BPYC-133

LOGIC

SCHOOL OF INTERDISCIPLINARY AND TRANS-DISCIPLINARY STUDIES (SOITS)

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COURSE INTRODUCTION

Logic (BPYC-133) is a six credit course meant for learners of BAG Philosophy. It is a core course, wherein the learners will become acquainted with the various aspects and concepts related to Logic. This course is comprised of 3 blocks and further divided into 14 units.

Humans are relational beings, who not just expresses their feelings and thoughts, but also communicate them with others. This need for communication and inter-action is founded upon the notions of relationality and shareability. We wish to and are able to communicate successfully, because we implicitly believe that the other has the capacity to understand what we express and we hope that the other would in fact understand our words, gestures and expressions. In a majority of situations, where humans interact and communicate, we aim at sharing not only our beliefs and desires, but also information which we have ourselves acquired from somewhere. In such cases, we make assertions and claims of the kind “This is so and so”. As a response to this claim, the other person may need and even demand a further justification for substantiating the veracity and correctness of the claim being made. The question then is not merely about how we know what we know, but how we can prove, justify, and ascertain its correctness. Most generally, the *set* of statements we make use of in order to prove or justify our claims can be called an “argument”. So, every time we are justifying a certain assertion or claim, we may say that we are constructing an argument in support of it.

Suppose, we were to claim that “X is mortal”.

And justify our claim with the following reasoning:

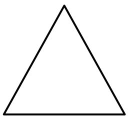
All humans are mortal.

X is a human.

Therefore, X is mortal (Our claim).

Let’s take another example:

Look at this figure →



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With regard to this figure we may claim or assert that “This is a figure of a triangle” (Claim)

We may justify this claim with the following reasoning:

> All figures whose inner angles sum up to 180 degrees are figures of triangles.
>
> The angles of this figure sum up to 180 degrees.
>
> Therefore, This is a figure of a triangle. (Claim)

It may be noted that our claims in these above examples can be deduced from the statements given to justify/prove the claim. The claim, along with the justificatory statements, is what formally constitutes an argument. Our claim can be identified as the “conclusion” and the statement(s) that are presented to justify our claim are identified as “premise(s)” of the argument. If the conclusion can be deduced from/implied by the premise(s), without a contradiction, then such an argument can be appraised as being a valid argument, otherwise if no such deduction can be made without falling into contradiction and inconsistency then the argument remains invalid.

Let us take another example similar to the 1st one above,

> All humans are immortal.
>
> X is human.
>
> Therefore, X is immortal (our claim).

While we can see that this argument is valid, but the more important question concerns why this is so. Our argument is said to be valid when our claim/conclusion is implied by the given premises.

But there may be someone, who may hesitate in accepting our claim, because the very first premise stands in contradiction to ordinary experience, whereby we find that all humans are subject to birth and dying and are definitely not “immortal”. The first premise, “All humans are immortal.” is clearly *not* true, it is not telling us truly what is actually the case. In such a situation, the appraisal of our argument is further qualified by suggesting that though it is indeed valid, but it is not “sound”. That is to say, that though it is valid, but it is not giving us any information about the way the world in fact is or could possibly be like.

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The above discussion allows us to understand how the very exercise of Logic is constituted by the study of the rules and methods that allow us to distinguish bad and good; proper and improper arguments; correct and incorrect reasoning.

Turning onto our first example again, we would find that the statement: “All humans are mortal” is a universal/generalized statement which aims at telling us something about *all* humans without any exception. It may however be asked how such a generalization is even possible, when all that we can ever be acquainted with are only some particular instances of individuals belonging to the human species; how are we even able to make a claim about unknown and yet unseen instances? There clearly appears to be a leap, which this “general” statement is making. Yet, despite the presence of this obvious jump, it needs to be noted that it is primarily through this kind of reasoning that our everyday assessments about objects, situations, individuals, as well as almost the whole of scientific knowledge and predictions have been advanced and developed. And interestingly, Logic also happens to be equally concerned with this kind of reasoning as well.

Further still, we would notice that the whole exercise of knowledge, i.e., wanting to know something is not only aimed at gathering information, but also aimed at achieving certainty and precision. Not only do we wish to know things, but we also want to know them with utmost certainty. But when we reflect upon the nature of language (the most evident medium of communication), we find that there is a possibility of hinderance in our quest of certain knowledge. While we aim at making our thoughts and communications as clear, unambiguous, and consistent as possible, language colors it with ambiguity and vagueness. We find that on the one hand there can be multiple meanings conveyed by the very same word, and on the other hand there can be a number of different words which render the very same meaning; in addition, accent too plays a major role in ambiguating communication. This ambiguity of meaning, together with our reliance on certain belief systems and social norms is what ends up (on many occasions) making our arguments fallacious, and hampering the overall quality of reasoning. In the course of the included units, the learner will also become conversant with the nature of fallacious reasoning, and the tools which can help us identify and thereby avoid such incorrect usage of arguments.

Summarily, therefore, the present course not only aims at introducing the learners to the domain of Logic; the foundational concepts; the relation between logic and language; fallacies in argumentation; etc. but it will also acquaint them with the various modalities in which this exercise has been theorized about, including the developmental shift that took place from traditional to symbolic logical systems. We sincerely hope that this course will prove to be really helpful in equipping the learners to understand and point out the differences between correct and incorrect reasoning and argumentation.

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Block 1

NATURE OF LOGIC

Block 1 “Nature of Logic” comprised of four units and deals with the definition of logic, a brief sketch of the history of its development, kinds of logic, the significance of, core concepts of logic, the difference between the approaches of Indian and western logic and so on.

Unit 1 “Introduction to Logic” introduces the basic theme of Logic, its subject-matter, nature and scope and the issues Logic primarily deals with. It gives an overview of the principal sub-divisions within this subject, giving an indication about the *kinds* or *species* of Logic that gradually emerge from its broadest characterization or its genus. The key terms and concepts of Logic get addressed as common-sense notions embedded in our intuitive understanding of the subject. This unit also outlines the Indian approach to Logic and tries to present its difference with the western approach to logic.

Unit 2 “Basic Concepts in Logic” introduces the core concepts pertaining to the subject-matter of Logic. The notion of validity/invalidity, arguments, proposition, the distinction between sentence and proposition, the distinction between argument and argument-form, proposition and proposition-form etc. are the themes addressed in this unit. The main focus of this unit is on deductive logic. Indian logic has its own vocabulary. This unit also elucidates the vocabulary of Indian logic.

Unit 3 “Inductive and Deductive Logic” aims at familiarizing learners with the nature and scope of deductive logic (formal logic) and inductive logic (material logic). This unit will elaborate on the intricate features of these two types of logical reasoning. This unit highlights the role played by reasoning and inference in the development of Logic. This unit tries to present; the comparison between two types of the reasoning process, the distinction between universalization and generalization, different types of inductions.

Unit 4 “Truth and Validity” elaborates the concepts of Truth and Validity in Logic. This unit discusses; the meaning and importance of truth and validity in Logic, the relationship between truth and validity in Deductive Logic, the applicable similar concepts in Inductive Logic, the applicable similar concepts in Indian Logic.

UNIT 1 INTRODUCTION TO LOGIC[*]

Structure

1.0 Objectives

1.1 Introduction

1.2 Definition of Logic – Argument and Proposition

1.3 Demarcating Logic from other descriptive sciences

1.4 Inductive Logic- Providing the basic tools of Scientific Inquiry

1.5 The Distinction between Logic and Psychology

1.6 Logic Versus Ethics and Aesthetics

1.7 The Distinction and Relation between Deductive Logic and Inductive Logic

1.8 How does Western Deductive Logic differ from Indian Logic?

1.9 The Rule of Universal Concomitance (Vyāpti) as the basis of Inference in Nyāya school of Indian Logic

1.10 Deductive Logic: Growing Levels of Complexities

1.11 Let Us Sum Up

1.12 Key Words

1.13 Further Readings and References

1.14 Answers to Check Your Progress

1.0 OBJECTIVES

The objectives of this unit are,

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- to introduce the basic theme of Logic, its subject-matter, its nature and scope and the questions and issues it primarily deals with.
- to identify the issues that fall beyond its purview.
- to give an overview of the principal sub-divisions within this subject, giving an indication about the *kinds* or *species* of Logic that gradually emerge from its broadest characterization or its genus. While the key terms and concepts of Logic get addressed in the natural course of this elucidation, they are not posed in a technical format, but rather as common-sense notions embedded in our intuitive understanding of the subject.
- to discuss the difference between the Western and Indian approaches to Logic.

1.1 INTRODUCTION

Logic is a kind of normative science that needs to be distinguished from descriptive sciences on the one hand and other normative sciences (Ethics and Aesthetics) on the other. The distinction between two major branches of Logic – Inductive and Deductive - is articulated in a way that ensures a necessary transition from the former to the latter. This in its turn invites a comparison between the Western and Indian approaches to this discipline, showing the latter as having a more expansive purview, moving beyond the *decontextualised* and *formal validity* of arguments. The provision within some Indian theories of logic, of incorporating the mechanism of knowing general essences that form the basis of arguments, has also been discussed. Lastly the way Western Logic moves from preliminary tools to incorporate more and more complex kinds of arguments have been indicated.

1.2 DEFINITION OF LOGIC – ARGUMENT AND PROPOSITION

Logic is a science which teaches you to argue correctly. This would mean that Logic deals with the norms or standards of valid arguments.

What is an Argument? It is a set of (at least two) propositions in which one or more propositions are claimed to be the ground of another proposition to be deduced. The ground propositions are called ‘premises/premisses[*]’ and the deduced proposition is called ‘conclusion’.

What are Propositions? Propositions are meanings of indicative sentences. Indicative sentences are those which, as contrasted with questions, commands, optations, etc., can be used to make statements that are true/false.

Arguments can be composed only of propositions or statements and not of questions or commands.

Take the stock example of an argument:

All men are mortal

Ram is a man

▪ Ram is mortal

All the constituent sentences are indicative. Suppose we turn each of these statements into other non-indicative moods –

Are all men mortal?

Oh I wish Ram were a man!

From these two sentences we cannot derive any other sentence – either in an indicative or in a non-indicative mood. So we need propositions for constructing arguments in Logic.

1.3 DEMARCATING LOGIC FROM OTHER DESCRIPTIVE SCIENCES

Logic is not a descriptive study like History, Geography, Physics, Chemistry, Biology or Anthropology. These disciplines deal with observation and discovery of facts, and many of them

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[*] *Premise* and *Premiss*, both, are used interchangeably.

conduct experiments to find out new facts. Logic does not undertake observation or description of facts, nor experiments to enable fresh discovery of facts

Logic in its broadest sense deals with the *ways and norms* of observing facts and of gleaning information from the natural world. The special force of logic however consists in this query - once facts are procured what will be the ways of moving to new facts, not on the basis of new observations and experiments, but on the basis of already known facts, coupled with the *norms of reasoning*.

Let us try to understand with an example as to how Logic- in the broadest sense of the term - carries out these two basic agendas.

Logic will discriminate between the proper and improper ways of forming generalization. Take two generalities-

i. All mammals are warm blooded
ii. All incidences of malaria are cured by chloroquine phosphate.

The above generalities are formed by proper methods of scientific enquiry – e.g. further investigation into the physiology of mammals and its possible connection with their being warm blooded, or empirically confirming that each malaria patient gets cured by administering the chloroquine drug and careful recording of any negative instance.

By contrast take the general statements - All crows are black or All crows peck when a human approaches their nest. Such generalizations are based on a loose collection of superficial observation, and not on any attempt to record counter examples, setting up control groups, or a deeper probe into the biological constitution of the crows. Now once these generalities like (i) and (ii) are established in the respective sciences logic will further teach us the proper ways of arriving at new facts - without any further observation. For instance, suppose someone argues –

All cases where anthrax antitoxin is administered to an animal affected by this disease will be cured.

This Anthrax -infected cow has been cured.

▪ It has been given the anthrax antitoxin.

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Here Logic will point out that this argument is invalid. It was never a claim of the initial generalization that anthrax antitoxin is the only antidote of Anthrax, for there may be other ways of curing the infection. From an affirmation of an Anthrax patient's cure one cannot deduce the conclusion that it had been treated with the unique antidote.

Here we find an invalid argument where Logic identifies a general form of invalidity. This invalid form is –

If P then Q

Q

▪ **P**

This invalid form has a corresponding form of validity which is –

If P then Q

P

▪ **Q**

These forms or laws of validity and invalidity are not derived from experience. Nor are the norms of forming correct generalizations, though they take help of experience, they are not exclusively based on experience. So logic is not an empirical science that describes and records experiential data. It deals with the norms or standards - not only of finding and describing new data - but mainly with the *norms of deducing new statements exclusively from the old and familiar ones, without the aid of any further experience*.

- The first agenda of finding the standards of correct discovery and formulation of facts belongs to a particular branch of Logic viz. *Inductive Logic.*
- The second task of deducing further facts from the facts that are already established independent of experience, defines the nature and scope of *Deductive Logic*.

(Learners are advised to substantiate their answers by using their own illustrations and examples, wherever applicable.)

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Check Your Progress I

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. Why is Logic a normative science?

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1.4 INDUCTIVE LOGIC- PROVIDING THE TOOLS OF SCIENTIFIC INQUIRY

Inductive Logic is claimed to improvise norms of discovering new facts and establishing scientific law statements. But it is important to appreciate that this does not turn Inductive Logic into the descriptive sciences like History, Geography, Physics or Chemistry. To find out the proper ways of utilizing our faculty of experience, or articulating the norms of establishing law statements with the aid of experience is not the same as conducting an actual empirical investigation – say conducting a survey of the relics of an ancient civilization or examining old documents for exploring the incidents of remote past. Nor does Inductive Logic include such activities as mixing two gases, viz. Hydrogen and oxygen in a definite proportion to find out whether they combine to form water.

Then what is exactly the task of formulating the norms of establishing general or particular facts with the aid of1 experience? Here we can outline the content of Inductive Logic in broad brushes – by a brief survey of the norms of empirical investigation and of establishing scientific generalities - as laid down by this discipline.

- **Mill's Methods of Experimental enquiry**

i. Method of Agreement

ii. Method of Difference

iii. Joint Method of Agreement and Difference

iv. Method of Concomitant Variation

v. Method of Residues

- **Analogical Arguments**

- **Science and Hypothesis**

i. Difference between Scientific and Unscientific Explanation.
ii. Criteria for Evaluating Scientific Explanation
iii. Application of the norms of good hypothesis to concrete cases of scientific investigation

A more concrete idea about these norms can be shaped up by considering the first of Mill's methods – viz. The Method of Agreement

A simplified statement of this method runs as follows –

The one factor or circumstance that is *common* to all the cases of the phenomenon under investigation is likely to be the cause (or effect) of that phenomenon.

The scientist intending to find out the cause of malaria goes on collecting as many instances as possible. He may note that the instances collected so far share a common circumstance - viz. the patient caching cold. However if he goes on to generalize that malaria is a disease that is caused by the virus of cold. It will not satisfy the Method of Agreement stated above. Cold may not be the *only* circumstance shared commonly by all the instances recorded so far; the crucial factor of mosquito bite has been ignored in this investigation. Besides a more comprehensive intake of the data will show that not *all* the cases of malaria agree to the circumstance of catching cold; patients without such precedents also come to be affected by this disease. This discovery will lead the scientist to discard the factor of catching cold, or eating a particular kind of food, or a skin infection, etc., as being the possible causes of malaria. Once the mosquito bite has been identified as the *only* circumstance in which *all* the instances agree, further investigation will help the scientist identify a particular species of mosquito - viz. anopheles – as being the carrier of the malarial germ.

From this simple instance we can appreciate that Inductive logic provides valuable tools for all the empirical sciences, though it itself is not an empirical science. Investigation into the virological details of cold, the physical features of the areas showing the maximum incidence of malaria, microscopic dissection of the anopheles mosquitoes, will not enter into the purview of Inductive Logic. It will stay aloof of these fleshy and raw details of the material world to prescribe abstract norms of empirical investigation.

It should be noted that these norms of scientific investigation – say Mill’s methods – apply not only to biology, physiology or virology, but also to physics and chemistry, as well as to the social sciences like history, geography, sociology, economics, cultural studies, feminist studies, and even to literature and linguistics. Lastly, since Logic is the method of all disciplines, it is also a method of Philosophy, rather Logic is an essential component of Philosophy.

1.5 THE DISTINCTION BETWEEN LOGIC AND PSYCHOLOGY

Logic should not also be confused with another descriptive science, viz. psychology. Psychology deals with our mental processes like cognition, feeling and willing. When we have cognition of the general facts of Nature, when we consider the norms of experimental investigation, when we move from one proposition to another through laws of logic, we go through emotions, stress and anxiety about getting the correct results, or uncertainties about our own competence, insurgence of fresh volitions to plunge into fresh arguments. These psychological states are invariably associated with our process of arguing. However Logic has to abstract its arguments from all these psychological accompaniments and present in a neat and clean shape.

1.6 LOGIC VERSUS ETHICS AND AESTHETICS

To have a more pointed grasp of the nature and scope of Logic we should further try to demarcate it from the other normative sciences like ethics and aesthetics. Ethics, like Logic and unlike Psychology, abstains from any description of facts. Ethics does not describe what people do, or how their psychological states occur in a causal chain. It is a study of how people *should* behave and accordingly tries to find out the norms to which human conduct should conform. For instance Ethics comes out with the norm (A) viz. everyone should act in a way that brings out maximum amount of happiness for the maximum number of people. Aesthetics comes up with certain criteria of appreciating beauty, say a handwriting is said to be beautiful if the letters are evenly spaced, the writing line is used as the baseline, and the height of the ascending letters keep a definite proportion with the baseline. Now Logic does not strive to find norms for appreciating human conduct or standards for judging the beauty of an object. It is concerned with the validity of arguments, whether one proposition follows legitimately from another. Taking (A) to be true Logic will formulate norms for arriving at further propositions, without any reliance on any further norm of human conduct. In similar ways Logic would distance itself from Ethics.

Check Your Progress II

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. What is the similarity and difference between Logic and Ethics?

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1.7 THE DISTINCTION AND RELATION BETWEEN DEDUCTIVE LOGIC AND INDUCTIVE LOGIC

1.7.1 Limitations in the Method of Induction

The mutual distinction between these two approaches of Logic also determines the exact pattern of their inter-relation. Actually Deductive Logic has come to pervade the exact arena of Western Logic delimiting the scope of Logic in a particular way. One can say that certain lacunas of Inductive Logic have compelled a transition to Deductive Logic.

We have already noted that the general pattern of establishing general propositions by Inductive Logic or by Induction is as follows:

Man_1 is mortal.

Man_2 is mortal.

Man_3 is mortal.

………….

$\text{Man}_{10000000000}$ is mortal.

No instance to the contrary has been found so far.

∴ All men are mortal.

Inductive Logic also seeks to derive particular (not general) propositions about a particular object **a** as possessing certain features (B, C, D etc.) solely on the basis of another object **b** similar to **a**, possessing apparently the same features (B, C, D etc.) Such an argument-pattern dubbed as 'Arguments by Analogy' finds a typical example in the following narration:

There is a great similarity between Earth and the other planets like Saturn, Jupiter, Mars, Venus, etc. They all revolve around their own axis and light from the sun, many of them have moons and are subject to the laws of gravitation. Hence it is highly probable that these planets too are inhabited by living creatures as Earth is.

None of the two kinds of inductive arguments (Argument by enumeration of particular instances and Analogical Reasoning) are foolproof techniques. However as we have already noted, Inductive Logic is indeed equipped with more sophisticated methods for arriving at generalizations – say Mill's methods of Experimental Enquiry. Mill's Method of Difference prescribes the task of finding the sole circumstance in which the phenomenon under investigation (say malaria) would *differ* from cases where the disease does not occur. Further it also prescribes the method of finding a common pattern of variation among two phenomena –say increase or decrease of a certain kind of food-consumption and the frequency of a certain disease, or the ascending and descending degrees of molecular movement according with the varying intensity of heat.

Inductive Logic also charts out the criteria of forming good hypothesis, and upgrading them to the status of law. Such steps of scientific investigation will be –

1. Devising Preliminary Hypothesis (a conjecture about a disease being caused by an external infection, like an insect-bite)

2. Collecting Additional data
3. Formulating Explanatory Hypothesis
4. Testing the Consequences
5. Applying the Theory

Let us note that an Explanatory hypothesis, as contrasted with the Preliminary one, goes down to a deeper level of linking itself with the phenomenon under investigation. For instance applying heat upto 100 ^{0}C to water would be the *preliminary* hypothesis to explain the phenomenon of boiling, but going down to the molecular structure (H_2O composition) of water and linking this with the phenomenon of water showing bubbles on its surface (at 100 ^{0}C) will be an instance of formulating an *explanatory* hypothesis

Now let us come back to our previous worry about the limitations of Inductive Logic. However much a scientist dissects the composition of water he cannot deduce a unique boiling point from this composition. To afford such a deduction with absolute certainty the scientist needs to be equipped with the additional premise which may be stated as follows –

The standard descriptions of water, the applied heat and the atmospheric conditions, exhaust the entire content and identity of water and fire.

And this presupposition may well be false. Suppose there exists in addition to the known atoms of hydrogen and oxygen some unknown elements (viz. *x*) which remain unexplored in the atomic theory. In that case the entire substance familiarly known as 'water' and structured as 'H_2O'*plus* some bundles of *x* get into some complex kind of causal inter-relations. In other words it is perfectly possible that when we present the standard compositions of water and fire, we are only giving a partial description of these substances, and also that we are leaving out some elusive factors in our environment which may interact with water and fire to change the standard boiling point of water on future occasions.

So from the standard descriptions of water, heat, electricity, plus the known laws of physics, a scientist can only deduce that water will boil at 100 ^{0}C and no other temperature, *as long as there is no remainder in the structure of water and heat* and the surrounding light and air molecules, and no intractable interaction among these .

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It is not a fact of pure logic or pure conceptual cum definitional connection that water has a unique boiling point at 100^0C. Similar remarks will apply to all men being mortal, Typhoid being curable by penicillin, or malaria being caused by anopheles. We cannot perform the above deductions in the way we can deduce Ram being mortal from all men being mortal and Ram being a man. Or the way we can deduce Ram being an unmarried man from Ram being a bachelor.

Thus Inductive Logic, with all its tools of sophistication can only *induce, incline* or *bend* us towards a particular conclusion. It can assure a high degree of probability, but not the full certainty.

1.7.2 Transition from Induction to Deduction

It is in this way that Deductive Logic intervenes and comes to cover the entire arena of Logic. The agenda of Deductive Logic is this – Provided that Inductive Logic supplies us with true propositions - say (i) Water having an H_2O structure will boil at 100^0C ,and that (ii) The liquid in Caspian Sea has an H_2O structure, then we can safely deduce (iii) This particular liquid in the Caspian Sea will boil at 100^0C. But whether the premises (i) and (ii) are true/false is not the task of Deductive Logic to ascertain.

It may seem that Deductive Logic undertakes the trivial operation of ceremoniously *deducing* certain propositions as *conclusions* – though they were already stated in the premises. However there are at least two significant and non-trivial tasks that Deductive Logic delivers:

1. It performs the task of extracting a conclusion – which although stated in the premises – is stated implicitly, in a camouflaged or obtuse manner

For instance take the following argument –

The Baron loves all who love Alma.

The Baron loves Alma

∴ The Baron loves himself.

The above argument, though valid, may not be obviously valid, for the simple reason that we often take the first premiss (viz. Baron loves all who love Alma) as excluding the Baron himself, presupposing that love is not the kind of relationship that a person can enter with himself. *Logic teaches us the lesson of freeing statements of their extra load of socially inculcated values and presumptions and trains us to take them in their stark, literal sense*.

2. Deductive Logic trains us not to be swayed away by familiar factual content of the premises and conclusion of the argument. It instructs us to concentrate not on the truth of the proposed conclusion in an isolated fashion, but whether that truth follows from the truth of the premises.

Take the following argument –

All women are bipeds

Khairee is not a woman.

∴ Khairee is not a biped

(Note: Khairee was a lioness brought up by a human family as their daughter since she was a cub - a fact not relevant for evaluating the validity of this argument).

Here all the premises as well as the conclusion are true, but the truth of the conclusion does not follow from the truth of the premises. While the class of women is included in the class of bipeds, the latter class may be more extensive to include beings that are not women, viz. birds. From the fact that Khairee is placed outside the class of women, we cannot deduce that Khairee is not a biped. That Khairee is a lioness is not informed to us in the above argument, and hence we cannot take that as a premiss.

While on the one hand Deductive Logic teaches us not to be swayed by the truth of the premisses, at the same time it also teaches us not be dissuaded by their falsity. One can construct innumerable valid arguments with false premises and a false conclusion.

Let us only take one such argument –

All women are three-legged

This lioness is a woman

∴ This lioness is three-legged.

It turns out that Deductive Logic deals only with the formal structure of arguments and not with their content. Western Formal Logic invites us to look upon all arguments pertaining to widely different subjects - physics, chemistry, biology, mathematics, sociology, psychology – only as certain formal arrangements of word-types. These word-types more or less correspond to the notion of parts of speech, a notion that we learned from our school-book grammar. Examples of these word-types will be:

i. Proper names or definite descriptions: 'Rajib', 'Mississippi', 'Mahabharata', 'the Grand Canyon', 'the present Prime Minister of India, 'this dream', 'this molecule', 'the square root of 4', etc.

ii. Common names or Predicate-words: man, mortal, state, river, atoms, quarks, metal, gas, dream, star, nerve, muscle, novel, metaphor, pain, itching, etc.

iii. Relational common names or relational predicate-words: loves, teaches, is jealous of, older than, is larger than, is adjacent to, etc.

One can easily appreciate how the above word-types can be used to form different propositions pertaining to different subjects. It is also easy to understand that apart from these variant proper names and predicates there will be some constant features across all arguments across all subjects.

iv. These will be quantifiers – 'All', None', Some', No', and various forms of the verb 'to be'.

Deductive Logic instructs us to identify these word-types or parts of speech and put specific symbols for each word-type, while keeping the quantifiers and verb-to-be intact. Hereby we can extract various forms of arguments – from which Deductive Logic goes on to identify which forms are valid and which are invalid.

1. All objects in motion move in a straight line

This is an object in motion

∴ This object will move in straight line

Putting S and P respectively for the subject and predicate of the conclusion, putting M for the third term figuring in the premises, and keeping the constants intact, we procure the following as a valid form

All M is P

This S is M

▪ This S is P

2. Nobody drinking half a litre of methylated spirit survives

That person drank that amount of spirit from a bottle.

▪ That person will die (will not survive)

No M is P

This S is M

▪ This S is not-P

3. All sensations are things that have local signs

All things having local signs can be measured

▪ Some things that can be measured are sensations.

All P is M

All M is S

▪ Some S is P

4. All planets are objects that obey the law of gravitation

Some celestial bodies do not obey the law of gravitation.

▪ Some celestial bodies are not planets.

All P is M

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Some S is not M

▪ Some S is not P

We have identified four valid forms of argument – each of these arguments come from a specific area. 1 pertains to Physics. 2 pertains to Medicine, 3 pertains to Psychology and 4 belongs to Astronomy.

Exercise: Take each valid argument-form and fill it out by putting proper names and predicates for each symbol. Be careful that once you substitute specific terms for S, P and M in one proposition you must substitute the same term for the recurrence of S, P and M in the other propositions.

Substitute Form 1 by deriving the terms from Geometry. Thus you get a valid argument in Geometry.

Substitute Form 2 by deriving the terms from Biology. Thus you get a valid argument in Biology.

Substitute Form 3 by deriving the terms from Literature. Thus you get a valid argument in Literature.

Substitute Form 4 by deriving the terms from Sociology – thus getting a valid argument in Sociology.

(Do not bother about the truth/falsity of the propositions yielded)

The above exercise should convince us that Deductive Logic is subject-neutral or content-neutral, it is actually not about the world – whether it is the world of Physics, or the human body, or the socio-political life, or about the inner world of our sensations and emotions. *Deductive Logic is simply about the linguistic forms of statements to ensure that new statements can derived from given statements solely on the basis of given forms.*

Check Your Progress III

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

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1. In what sense is Deductive Logic only formal?

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2. Why is Inductive Logic said to arrive only at probabilities and not certainties?

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1.8 HOW DOES WESTERN DEDUCTIVE LOGIC DIFFER FROM INDIAN LOGIC?

We see that Deductive Logic delinks the notion of validity from truth and also the process of inference from the product. Indian Logic by contrast does not adopt either of these methods of abstraction.

First, Indian Logic deals with the procedure of establishing a necessary connexion between the ground of inference (*hetu*) and the inferrable property (*sādhya*)

Secondly, it deals with the epistemological procedures of establishing the particular truths stated in the premises, viz. Ram being a man, or this liquid being water etc.

Thirdly it concerns itself with the order in which our cognitions occur stepwise – starting from the premises leading upto the conclusion.

For Deductive Logic on the other hand the ways of establishing the truth of the premises or the order in which the cognitions develop from the premises to the conclusion does not fall within its scope.

1.8.1 The wider notion of Inference in Indian Logic

Hence Indian logic uses the vocabulary – not of ‘argument’ but ‘inference’, which further ramifies into two sub-notions – of inferential cognition (*anumiti*) and the instrument or cause of inferential cognition (technically dubbed as *anumāna*) . This notion of inference (*anumāna* and *anumiti*) tracing the process through which one cognition finally gives rise to the conclusion is clearly a much richer notion than that of an ‘argument’ typically used in Deductive Logic. The latter abstracts not only from the content but also from cognitive phases through which the premises upgrade themselves to the conclusion.

That the Indian Logicians takes logic as a cognitive development gets manifest in the format of an inference typically used in the the *Nyāya* system.

a. Wherever there is smoke there is fire

b. This hill has fire

c. Smoke marked by the invariable presence of smoke is present in this hill.

d. ▪ This hill has fire.

Let us note that Western Deductive Logic will allow b to entail d straightforwardly without needing the further step of c. Nor is Deductive Logic interested in charting out the steps chronologically. However the *Nyāya* school of Indian Logic takes care to narrate that in any inference we *first* see a site characterised by a mark or a *hetu* – say a hill emitting smoke, *followed by* a remembrance of the universal co-presence of smoke and fire, further *followed* by the *assurance* that the smoke that we see comes under this universal rule. It is this *application of the universal to a particular instance* coming *last* in the series of cognition that immediately generates the *fina*l inferential cognition viz. ‘The hill has fire’.

1.8.2 Illustrations of valid arguments in Indian Logic

(i) This particular place has no jar because it is not perceived – just as we perceive no flower growing in the sky - although the conditions of perception are fulfilled

(ii) The sounds of speech are impermanent entities because they are produced at will.

Whatsoever is produced at will is impermanent, e.g. a jar etc.

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(iii) This is a tree because it is *Asoka*.

(The last three illustrations are taken from *Bauddha* school/Buddhist Logic).

(iv) Since the *krittikā* star is rising the *śakaṭa* star will rise a *muhūrta* (48 minutes) later.

(v) There is moon in the sky because there is reflection of the moon in water'

(vi) 'The sun is above because the earth is illuminated'.

(The last three illustrations are taken from *Jaina* logic.)

Let us note that all the above inferences are not in the same format – in some instances the main general premiss is suppressed. This is because for some schools of Indian Logic a person undertaking an inferential cognition for himself does not need to register the general premiss as a separate statement, though he needs it to demonstrate the inferential connection to a third person, or on a public platform. As Deductive Logic freezes the live process of inference into a timeless structure, devoid of any specific needs, interests or orientations of the subject, it is not sensitive to the possible variations in the layout of the inference in different contexts.

There are internal differences among various schools of the Indian logicians themselves, and yet they all agree in their common approach to Logic being about reality and not being merely about linguistic forms.

1.8.3 Fallacies in Indian Logic that pertain to Content

Besides Indian logicians also track down the possible ways in which an inference will incur a falsity in its premises and categorises that as a logical fallacy. Some examples of fallacious arguments owing to the *falsity* or other lapses in the *content* of the premises are cited below –

i. The hill has smoke because it has fire, and all loci of fire contain smoke.

(Note: Every locus of fire does not have smoke, hence the falsity of the general premise makes it an invalid inference. For Deductive Logic however, since the argument has a valid format viz. Form 1 specified in the last part of Sec 6. Hence it is valid, though *unsound* (due to the falsity of at least one of its premises.). Indian Logic is however committed to a more expansive notion of validity that encompasses the notion of *soundness* i.e., factual content and truth of the premises and conclusion as well.

ii. Sound is eternal because it is an effect

(Note that no eternal thing can be generated as an effect, hence the very general statement serving as the required basis of this inference is false. This is also identified as a kind of fallacy in Indian Logic)

iii. Wherever there is a peacock's cry it is present

The cry comes from that cave (probably)

Therefore the peacock is present in that cave (probably).

Note that here we have correctly identified the species of the animal and connect it with its presence. There is nothing wrong in the first premise and even in thinking that a peacock is present in the vicinity. But here we lapse into an error in locating the exact place that the cry is coming from, which falsifies our second premise. This error in identifying whether a property belongs to a particular object or location incurs a fallacy in Indian Logic - though for Deductive Logic it is formally valid – exemplifying the same form as cited above.

iv. An atom is composed of parts because it has atomicity in it.

v. The fur on the turtle is a source for blanket, because it is soft etc.

(Note that iv is fallacious because the mark of atomicity being present only in atoms the inference does not afford any occasion to check whether this mark is concomitant with the inferable property in *other* loci as well.

v is invalid in a more unusual manner – for the very object (fur on the turtle) which is concluded to be the source of blanket is itself a non-entity. A proposition with a subject term that refers to nothing fails to be true/false and thus disturbs the issue of validity or invalidity of the argument. Again this argument being a substitution of the Form 1 is formally valid from the standpoint of Deductive Logic.)

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The entirely formal or contentless character of Deductive Logic can be most pointedly registered in saying that none of the terms used in its arguments have any reference. The common names refer to a possible class, and the proper names like ‘Ram’ or even ‘this atom’ refers to possible particulars – just in the same fashion as ‘4’ and ‘triangle’ refer to abstract concepts. Thus our patent generality viz. ‘All men are mortal’ merely means that there is no individual who is both a man and is non-mortal. And *if* there is an existent individual named as Ram *then* that individual has the predicate of mortality. Indian Logic on the other hand commits itself to real reference of each term used in the formulation of its valid inferences.

Check Your Progress IV

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. How is the approach of Indian Logic different from that of Deductive Logic?

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2. What is the difference between the notion of argument in Deductive Logic and inference as conceived in Indian Logic?

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1.9 THE RULE OF UNIVERSAL CONCOMITANCE (VYĀPTI) AS THE BASIS OF INFERENCE IN NYĀYA SCHOOL OF INDIAN LOGIC

In order to ensure that the inference is a correct one the *hetu* has to be universally and unexceptionally pervaded by the *sādhya*. This required relation between the *hetu* and *sādhya* is called *vyāpti* or the rule of Concomitance. Here the qualification of the *vyāpti*-relation pertains to the *sādhya* – the *sādhya* must be such that it must never be absent where the *hetu* is present, (though the reverse might not always hold true). In our present example (Wherever there is smoke there is fire) fire is never absent in the locations of smoke, while the *hetu* or smoke is absent in some locations of fire (viz. the red hot iron ball) which shows that the *sādhya* is not pervaded by the *hetu*.

The suspicion of possible exceptions to *vyāpti* is to be overcome by a denial of the proposed rule, and this denial should entail a violation of the causal law. Such a procedure may be said to be an indirect argument or a *reduction ad absurdum* which takes the form: If smoke were not invariably pervaded by fire it would not have been produced by fire. But that fire causes smoke is an established law of Nature, and hence a counterfactual statement of there being smoke without fire as a possible exception to the rule would amount to a violation of the causal law.

1.10 DEDUCTIVE LOGIC: GROWING LEVELS OF COMPLEXITIES

It is because of its ‘formal limitations’ or formal purity that Deductive Logic reigns supreme in the arena of Logic. We shall wind up with an indication of how it develops its formal tools progressively to cope with arguments of newly emergent variations.

The most preliminary kind of Deductive Logic is Propositional Logic. This kind of logic is capable of dealing with a limited range of arguments - where a proof of their validity/invalidity depends on a layout of recurrent simple propositions contained in the argument – each simple proposition figuring as an ultimate unit of analysis. The proof of these arguments does not need one to get into the internal components of these simple propositions.

For example:

If this piece of litmus paper is put into acid it will turn red.

It has not turned red

▪ It is not put into acid

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To evaluate this argument we need only to identify the simple propositions and put an abbreviated symbol or a propositional variable for each such proposition uniformly. Taking p, q, r as propositional variables we get the following form of the above argument.

If p then q

Not q

▪ Not p

More complex arguments can be handled by Propositional Logic -

If Communism generates Equality then people will go for it and if Capitalism creates more wealth CO_2 emission will increase.

.Either people will go for Communism or CO_2 emission will increase.

▪ Either Communism generates Equality or Capitalism creates more wealth

Following the same method of substitution we get the following form

If p then q and if r then s

Either r or s

▪ Either p or q

This however is an invalid form - for since both these consequents (of people going for Communism and increase of CO_2 emission) can occur in other ways, than the way stated by the antecedent propositions. To turn this into a valid argument we just need to reverse the order of the second premise and the conclusion. Overall we find that these kinds of arguments simply need us to identify the simple propositions and the propositional connectives like ‘and’ ‘or’, ‘it is not the case that’ etc. , and to do the necessary substitution in order to extract the logical form.

Now there are other arguments which will need us to analyse the simple propositions further into their internal components. Our patent argument viz. ‘All men are mortal, Ram is a man, ▪ Ram is mortal’ is an example of this kind. A scrutiny into Form 1 mentioned in Sec 6 will show how

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this argument has been analysed into its constituent terms, and how these terms repeat themselves to shape up a valid argument-form.

The way arguments are analysed into subject-term (S), predicate-term (P) and middle term (M) was devised in the Aristotelian Logic. Deductive Logic in modern times, in the hands of Gottlob Frege and Bertrand Russell had taken a different style of analysis and symbolization. They have invoked two variables – one for individuals without general properties, and the other for properties floating freely of any individuals. The symbols chosen for individual variable are x, y, z etc. and those chosen for property variables are F and G.

Now in this style our good old argument will be symbolized as -

For all values of x if x is a F then x is G.

Ram is F

∴ Ram is G

Putting predicate constants for F and G we can get the original argument.

Frege and Russell have also prescribed the use of small letters a, b, c etc for the proper names like Ram, Mahabharata etc., and capital letters like H and M to abbreviate the predicate-constants like ‘man’ and ‘mortal’ respectively.

It is for this format of splitting the propositions into individual symbols and predicate-symbols that the Fregean method of logical symbolism came to be known as **Predicate Logic** as contrasted with Propositional Logic. It is also called **Quantificational logic** because this method of symbolism exhibits the *quantity* of individuals (*all*, *some* or a *single* individual) on which a predicate is applied. On the other hand the symbolism used in Propositional Logic did not have any scope or use for demonstrating the quantity of predication.

As arguments grow more complex – involving relational predicates (like ‘teaches’, ‘loves’, ‘kills’, ‘is jealous of’) the style of symbolism also has to get more and more incisive to make such arguments available to a method of testing or proof. This Logic comes to be termed as the **Logic of Relations.**

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Arguments that seek to derive certain beliefs and desires of humans from certain other beliefs and desires will have to develop a different set of axioms, inference rules and symbolism. This kind of logic is known as **Intensional Logic**.

Arguments that seek to derive the necessity /possibility of certain propositions from those of given propositions need more tools and resources that are contrived in a higher kind of logic called **Modal Logic.** All these higher categories of logic develop by adding to the axioms, rules of inference, or the symbolic conventions already accepted in the simpler kinds of logic.

1.11 LET US SUM UP

Logic is a science that formulates tools for evaluating arguments as valid or invalid. It is broadly classified into Deductive Logic and Inductive Logic. Deductive Logic delinks the form of the argument from its content and truth-value of its constituent propositions. It also severs the product of argument from the actual cognitive process. Inductive Logic engages with both the content and form of its arguments - but is ultimately able to deduce statements only with a high degree of probability and not with the fullest certainty. Deductive Logic claims to deduce conclusions with the fullest certainty, but only at the cost of sacrificing the content of the real world. Indian Logic seeks to blend the formal validity of arguments with the necessary truth and real content of its premises and conclusion.

1.12 KEY WORDS

Anumāna: the instrument or cause of inferential cognition

Argument: It is a set of (at least two) propositions in which one or more propositions are claimed to be the ground of another proposition to be deduced.

Conclusion: The deduced proposition in an argument is called ‘conclusion’.

Deductive logic: It is based on deduction. In deductive reasoning the conclusion is certain and conclusive, because it is already implied by its premises.

Hetu: ground of inference.

Inductive logic: Inductive logic *induce, incline* or *bend* us towards a particular conclusion. In inductive reasoning the conclusion is probable.

Premise: The ground propositions in an argument is called ‘premise/premiss.

Proposition: Propositions are meanings of indicative sentences.

Sādhya: inferrable property.

Vyāpti: the relation between the *hetu* and *sādhya*. It is an invariable relation.

1.13 FURTHER READINGS AND REFERENCES

- Copi I.M., and Cohen C, (ed) 2004, *Introduction to Logic,* Prentice Hall of India Pvt Ltd., Delhi.
- Copi, I.M., Cohen, C, McMohan K (ed) 2016, *Introduction to Logic,* Pearson, Delhi, Chennai. (for the chapter on Indian Logic)
- Hurley, P. (2014). *A Concise Introduction to Logic* (12th Revised edition), (Chapters 6, 7, 8), Wadsworth Publishing Co Inc.

1.14 ANSWERS TO CHECK YOUR PROGRESS

(Learners are advised to substantiate their answers by using their own illustrations and examples, wherever applicable.)

Check Your Progress I

1. **Hint:** Logic in its broadest sense deals with the *ways and norms* of observing facts and of gleaning information from the natural world. (Sec 1.3)

Check Your Progress II

1. **Hint:** Ethics is a normative study of how people should behave and accordingly tries to find out the norms to which human conduct should conform. (Sec 1.6)

Logic is a normative study of the rules governing the appraisal of arguments into good and bad; strong and weak.

Check Your Progress III

1. **Hint:** Deductive logic is merely concerned with the form and structure of an argument. (Sec. 1.7)

2. **Hint:** In inductive logic the conclusion is not already implied by premises, rather conclusion is only probabilistically suggested by the premises. (Sec. 1.7)

Check Your Progress IV

1. **Hint:** To establish the truth of the premises is not within the scope of deductive logic. Whereas Indian logic deals with the epistemological procedures of establishing the particular truths stated in the premises. (Sec. 1.8)

2. **Hint**: Deductive logic abstracts not only from the content but also from the cognitive phases through which the premises upgrade themselves to the conclusion.

(Sec. 1.8)

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UNIT 2 BASIC CONCEPTS IN LOGIC[*]

Structure

2.0 Objectives

2.1 Introduction

2.2 Argument and its Constituents: Premisses and Conclusion

2.3 Argument and Inference

2.4 Proposition – Its Difference from a Sentence

2.5 Validity/invalidity of Arguments: Truth-Value of its Constituents

2.6 Sound and Unsound Arguments

2.7 Deductive and Inductive Arguments

2.8 Types of Propositions: Categorical and Conditional

2.9 Aristotelian Logic

2.10 Symbolic Logic Vs Aristotelian logic

2.11 Statement-Forms or Propositional Forms

2.12 Argument-Forms

2.13 Propositional Logic Vs Predicate Logic or Quantificational Logic

2.14 Difference between Aristotelian Logic and Predicate-Logic or Quantificational Logic

2.15 Formal proof of Validity

2.16 Fallacies

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2.17 Indian Logic

2.18 Let Us Sum Up

2.19 Key Words

2.20 Further Readings and References

2.21 Answers Check Your Progress

2.0 OBJECTIVES

This Unit introduces the core concepts pertaining to the subject-matter of Logic. We know that Logic is a science that deals with the norms or standards of evaluating arguments as valid/invalid. Arguments are made of propositions and propositions have to be carefully distinguished from sentences. In this unit learner will study,

- the distinction between arguments and argument-forms, propositions and proposition-forms.
- the notion of validity/invalidity of arguments as contrasted with the truth/falsity of its constituent propositions.
- the basic terms and concepts of Indian logic and its distinguishing features.

2.1 INTRODUCTION

We start with arguments – the principal target of logic - with an aim to appreciate its abstract and conceptual nature as distinguished from a concrete piece of inference. Discussion about the notion of an argument will naturally take us to the notion of propositions or statements, as distinguished from sentences, and further to the principal *kinds* and *forms* of propositions and also *forms* of arguments – as distinguished from their *content*. The idea of familiarizing ourselves with propositional forms and argument-forms is to appreciate the formal notion of validity and invalidity with which Deductive Logic is concerned. The extensive use of symbols that comes to mark modern ‘symbolic logic, and its basic difference from Aristotelian logic are issues that are woven with the theme of validity. The notions of formal proof of validity and formal fallacies in invalid arguments naturally come up in this context.

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2.2 ARGUMENT AND ITS CONSTITUENTS: PREMISSES AND CONCLUSION

We know that Logic is a science which teaches you to argue correctly. This would mean that Logic deals with the norms or standards of valid arguments.

What is an Argument? It is a set of (at least two) propositions in which one or more propositions are claimed to be the ground of another proposition. The ground propositions are called **'premisses'** and the deduced proposition is called '**conclusion**'. Premisses and conclusion are propositions that are the **constituents** of an argument.

Let us consider some examples of arguments:

(1)Rajiv is a first class M.A and Rahul is a PhD

∴ Rahul is a PhD.

(2) Either Anshu is a first class M.A. or a second class M.A.

Anshu is not a first class M.A.

∴ Anshu is a second class M.A.

(3) If Arun comes then Arati will also come.

If Arati comes then Indranil will also come.

If Indranil comes then Utpal will also come.

∴ If Arun comes then Utpal will also come.

(1) has **two** constituents, i.e., its conclusion is deduced from **one** premiss,
(2) has **three** constituents, i.e., its conclusion is deduced from **two** premisses.
(3) Has **four** constituents, i.e., its conclusion is deduced from **three** premisses.

2.3 ARGUMENTS AND INFERENCE

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Inference *is a cognitive process which addresses the sequence through which the knowledge of the premisses leads to that of the conclusion*, coupled with the question whether the knowledge of the premisses is enough to lead to conclusion or whether other intermediaries are needed. **Argument** on the other hand abstracts itself from the temporal sequence of an inference, and presents itself as a neat end-product, where the questions whether the premisses precede the conclusion, or whether some psychological procedure needs to intervene between the premisses and the conclusion are irrelevant. As Deductive Logic seeks to make arguments independent of cognition of the premisses, it also thereby makes the validity of arguments independent of the truth/falsity of the premisses. Thus an *argument in this sense seeks to represent merely the conceptual or hypothetical connection between the premisses and the conclusion – independent of the cognition of the premisses or their truth/falsity.*

2.4 PROPOSITION: ITS DIFFERENCE FROM A SENTENCE

Propositions are meanings of indicative sentences or statements made by the use of indicative sentences. Indicative sentences are those which, as contrasted with questions, commands, optations, etc., can be used to make statements that are true/false.

Arguments can be composed only of propositions or statements and not of questions or commands.

Let us consider argument (2) Suppose the premisses are recast as -

Oh I wish either Anshu were a first class M.A. or were a second class M.A.!

Is Anshu not a first class M.A.?

I.e., we have turned each of the premisses into other non-indicative moods (a wish and a question).

From these two sentences we cannot derive any other sentence – either in an indicative or in a non-indicative mood. So we need propositions for constructing arguments in Logic.

A better way to define propositions or statements is to say that *propositions are those which can be true/false, i.e., those which have truth-value.*

The Difference between Indicative Sentence and Proposition: It must be noted that indicative sentences are not constituents of an argument. Sentences - including indicative sentences - are physical objects consisting of visible signs or audible sounds. Consider the following sentences:

It is raining. (English)

Es Regnet. (German)

Il Pleut. (French)

वर्षा भवति। (Varṣā bhavati)- (Sanskrit)

All of these mean the same - or rather they make the same statement - but as sentences or as series of physical marks they are different. It is thus obvious that what enters into the constituents of arguments are the meanings of sentences, or statements made by indicative sentences – which are propositions.

Terms and Propositions: Propositions are often said to be composed of three terms – the subject-term, the predicate-term and the copula – which joins the former with the latter.

(Learners are advised to substantiate their answers by using their own illustrations and examples, wherever applicable.)

Check Your Progress I

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. Distinguish between Proposition and Sentence.

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2.5 VALIDITY/INVALIDITY OF ARGUMENTS: TRUTH-VALUE OF ITS CONSTITUENTS

While a proposition is either **true** or **false**, an argument is either **valid** or **invalid**.

A valid argument is such that if its premisses are true its conclusion cannot be false. This does not mean that a valid argument has to have true premisses. *What validity of an argument demands is that it cannot be a combination of true premisses and a false conclusion, though it may have other combinations like those of false premisses and true conclusion, or false premisses and false conclusion, etc.*

E.g. If Rabindranath Tagore won a gold medal in swimming in the Olympic Games, then he donated it to Vishwabharati.

Rabindranath Tagore won a gold medal in swimming in the Olympic Games.

∴ He donated it to Vishwabharati.

This is a valid argument, though its second premiss and the conclusion are false. The crucial point for its validity is that if its premisses were true the conclusion could not have been false.

An *invalid argument* is such that even if its premisses are true it may still have a false conclusion. This means that an invalid argument can have all sorts of combinations of the truth-values of its premisses and conclusion.

E.g. If Rabindranath Tagore was born in Gariahat then he was born in Calcutta. (**True**, because Gariahat is a place in Calcutta)

Rabindranath Tagore was born in Calcutta. (**True**)

∴ Rabindranath Tagore was born in Gariahat. (**False**, because he was born in Jorasanko, not Gariahat)

2.6 SOUND AND UNSOUND ARGUMENTS

An argument is sound when it is valid and all its premisses are true. Suppose we make small changes in the above invalid argument to recast it as –

If Rabindranath Tagore was born in Jorasanko then he was born in Calcutta. (**True**, because Jorasanko is a place in Calcutta)

Rabindranath Tagore was born in Jorasanko. (**True**)

∴ Rabindranath Tagore was born in Kolkata. (**True**)

Here we get a **sound** argument.

2.7 DEDUCTIVE AND INDUCTIVE ARGUMENTS

In a valid deductive argument the conclusion repeats what is implicitly stated by the **premisses**, and hence the conclusion is claimed to be absolutely certain. This property can be appreciated in all the examples of valid arguments illustrated above. On the other hand an inductive argument takes a leap beyond what is stated in the premisses and thereby claims only a degree of probability, and not certainty. A typical example of an inductive argument will be -

Man_1 is mortal.

Man_2 is mortal.

Man_3 is mortal.

………….

$\text{Man}_{10000000000}$ is mortal.

No instance to the contrary has been found so far.

∴ All men are mortal.

2.8 TYPES OF PROPOSITIONS

If we look at the three arguments – (a), (b) and (c) cited above we see that they consist of two types of propositions – **simple** and **compound**. The propositions that are composed of the connective expressions like ‘and’ ‘or’ ‘if then’, are compound propositions and the propositions that are not compound are simple. So we can say-

The proposition which has at least one part that can itself be considered as a proposition is a compound proposition. To take one example from (2) Either Anshu is a first class M.A. or he is a second class M.A. It is clearly a compound proposition because it has *at least* one part (in fact two) which can themselves be considered as propositions.

The proposition is said to be atomic or simple, when no part of it can be considered to be a proposition. The proposition viz. 'Anshu is a second class M.A' is an atomic proposition, for though it has many parts – viz. 'Anshu', 'is', '1st class', etc. etc. , yet none of these parts itself amounts to a proposition.

Note that the proposition - 'It is not the case that Anshu is intelligent' - is also compound. Though it is not composed of two propositions connected by 'or' or 'and', still it fulfills the prescribed definition of compound proposition. It has a part viz. 'Anshu is intelligent' which itself is a proposition, and the entire proposition has to be deemed as compound.

From another point of view propositions can again be divided into two types – **categorical** and **conditional.** ***Categorical propositions*** *are those which make statements irrespective of any condition, whereas a* ***conditional proposition*** *makes a statement as qualified by some conditi*on. If I say - 'The ground is wet'– I am obviously predicating wetness of the ground irrespective of any condition; whereas , when I say – 'The ground is wet provided it rains' – I am introducing a conditional clause into this sentence and thereby making a conditional proposition. 'All men are mortal', 'Ram is a man' – both state categorical propositions. But the compound of all these three statements viz. 'If all men are mortal and Ram is a man, then Ram is mortal' will be a conditional proposition.

2.9 ARISTOTELIAN LOGIC

2.9.1 Fourfold Categorical Propositions

In Aristotle's Logic categorical propositions were mainly conceived in terms of classes – which may be roughly symbolized as S and P – i.e., the subject-class and the predicate class. Accordingly Aristotle conceives categorical propositions as being of four types – depending on whether the propositions affirms a full or partial inclusion of one class into another, or whether it denies a partial or full inclusion of one class into another.

Categorical Propositions - Four types

(A) All S is P (**Universal Affirmative –** affirming full inclusion of S into P)

E.g. All mammals are warm-blooded

All creatures with hearts are creatures with kidneys

(E) No S is P (**Universal Negative** – denies a partial inclusion of S into P. This means that it affirms a full exclusion of S from P and vice versa.)

E.g. No girl is born out the genetic code of XY chromosomes.

No reptiles are quadrupeds

(I) Some S is P (**Partial Affirmative** - a part of S is included in the class P)

E.g. Some poets are novelists

Some reptiles are bipeds

(O) Some S is not P (**Partial Negative** - a part of the class S is excluded from P)

E.g. Some politicians are not honest

Some universities are not funded by UGC.

2.9.2 Conditional propositions

Conditional propositions are also divided into at least two types - Hypothetical and Disjunctive.

Hypothetical propositions are of the form **If p then q–** If the COVID 19 vaccine turns out to be effective in 2021 I shall travel abroad.

Disjunctive propositions are of the form - **Either p or q**: Either COVID 19 vaccine does not turn out to be successful in 2021 or I shall travel abroad.

2.9.3 Immediate and Mediate Inference

Immediate Inferences are those where the conclusion is claimed to follow from a single premiss.

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All mammals are quadrupeds

∴ Some mammals are quadrupeds

All girls are born out XX genetic code

∴ Some beings not born out of XX genetic code of are not girls.

Mediate Inferences are those that have more than one premiss to entail the conclusion.

2.9.4 Mediate Inference: Syllogism and its Two types

Aristotle has a special term for two premised arguments – viz. **Syllogism**. Syllogisms will again be of two types - **Categorical Syllogism** and **Conditional Syllogism**.

Categorical Syllogisms will be those where all the constituent propositions – viz. the two premisses as well as the conclusion are categorical propositions.

Example (1) All girls are born out of the genetic code of XX chromosomes

No boys are born out of the genetic code of XY chromosomes.

∴ No boys are girls

Example (2)

No octopuses have kidneys like the humans

Some creatures with hearts have kidneys like humans.

∴Some creatures with hearts are not octopuses.

Conditional Syllogisms will be those which have at least one conditional proposition as its premiss – that is either hypothetical or disjunctive.

If the COVID 19 vaccine turns out to be effective in 2021 I shall travel abroad.

I shall not travel abroad

∴ The COVID 19 vaccine did not turn out to be effective in 2021.

(Note: The first premise is hypothetical and the second premise is categorical. It is accordingly called a hypothetical syllogism.)

Example 2

Either the COVID 19 Vaccine fails to be effective or I shall take a world-tour.

The COVID 19 vaccine did not fail to be effective

∴ I shall take a world-tour.

(Note: The first premiss is disjunctive and the second premiss is categorical. It is accordingly called a disjunctive syllogism.)

Aristotle constructed a strong framework of Categorical Syllogisms – detailing out its possible forms – Moods and Figures, Rules and Fallacies. (Details about Categorical Syllogism will be discussed in Unit 3.) However he did not lay out a fully developed system of conditional syllogisms – hence discussion of Aristotelian syllogisms are mainly confined to categorical syllogisms.

Check Your Progress II

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. What is the difference between Mediate and Immediate inference?

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2.10 SYMBOLIC LOGIC VS ARISTOTELIAN LOGIC

Aristotle was considered to be the founder of Logic, hence the term ‘Aristotelian Logic’ is usually used to describe traditional logic. This logic has progressively become more sophisticated in its tools and extensive it its field and has come to be termed as ‘Symbolic Logic’. However there is no fundamental difference between Aristotelian Logic and Symbolic

Logic. Both genres of Logic have to use symbols, though the use of symbols came to be more and more extensive with the passage of time, and hence the name ‘**Symbolic Logic’** is conferred upon the Logic that we see in the present day.

2.10.1 What is a symbol?

Any sign, i.e., a written or spoken mark that is used to represent something is known as a symbol. There are two kinds of symbols – **word-symbols** and **non-word symbols.** ‘Table’, ‘brown’, ‘walking’ are all word-symbols**,** *rather each word of our ordinary language is a symbol.*

There are non-word symbols that are used in special sciences – like those in mathematics – viz. ‘1’, ‘2’, ‘—1’, ‘+’, ‘– ’, ‘x’, ‘%,’‘=’, ‘>’, etc. - which are used to represent numbers and various relationships amongst numbers. *Logic being a special science has to use special non-word symbols lay out its arguments and methods for proving them to be valid/invalid.*

2.10.2 Kinds of Symbols: Variable Symbols and Constant-Symbols

Logic uses these two kinds of symbols.

2.10.2.1 Variable Symbols

Variable symbols are certain place-markers that take in specific kinds of values in its space. We know that Logic deals mainly with propositions that go to constitute arguments. Propositions are further made of terms. So Logic initially needs to have at least two kinds of place-markers or variables - (i) **propositional variables and (ii) term-variables.**

(i) Propositional variable will take in atomic or **simple** propositions as its values. English consonants in small case like p, q, r etc. are used as propositional variables. Let us consider argument 3 to see how we can replace its constituent atomic propositions by propositional variables.

If Arun comes then Arati will also come.

If Arati comes then Indranil will also come.

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If Indranil comes then Utpal will also come.

∴ If Arun comes then Utpal will also come.

It is obvious that each of the underlined expressions is an atomic proposition. By substituting each atomic proposition with a separate propositional variable the above argument turns out to be:

If p then q

If q then r

If r then s

∴ If p then s

Sometimes we need to get into the internal components of an atomic proposition, viz. to the terms. So here we need (ii) **term-variables** to symbolize an argument. Let us take the following term-variables like S (subject-term of the conclusion), P (predicate term of the conclusion) and M (middle term figuring in both the premisses) as term-variables to symbolize the following argument.

All teenagers are fun-loving

All School-children are teenagers

∴ All school children are fun loving.

All M is P

All S is M

All S is P

2.10.2.2 Constant-Symbols

Constants unlike variables are not place-markers, they do not take in values, thus the **constant symbols** of Logic serve to abbreviate the symbols that we already use in our ordinary or natural languages – like English, Bengali, Hindi etc. Note that the propositions and the propositional

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connectives that we use in our ordinary language are all constants, simply in the sense that they are not place-markers to take values. Let us focus on how Logic abbreviates these two kinds of constants, viz. the (i) **propositional constants** and the (ii) **propositional connective constants**

(i) Propositional Constants: First let us how logic turns the simple propositional constants into abbreviations like P, Q, R. Thus if we take argument 3 again, then using English alphabets P,Q. R, S etc. - each alphabet consistently for each atomic proposition - we get :

(A)

If P then Q

If Q then R

If R then S

∴ If P then S.

Thus we have got an abbreviation of the argument 3. Note the difference between (A) and the following -

(B)

If p then q

If q then r

If r then s

∴ If p then s.

*(A) is an **abbreviation** of the argument (3) while the (B) represents the **form** of (3).* From (A) you will only get the unique unabbreviated argument (3), while from (B) you can get many arguments of the same form. This is for the simple reason that for 'p', 'q', 'r', and 's' you can substitute many other atomic propositions like - It is raining, Rajendra Prasad was the President of India, Rajiv is dreaming etc., and get different arguments. But P, Q R, being specific abbreviations for specific propositions, the question of substitution does not arise.

To repeat: **(A) is an argument** (written in an abbreviated form) and (B) is an **argument-form**, not an argument (whether abbreviated or unabbreviated)

Further note: **'If p then q' – is not a proposition, but simply a propositional form** (like 'If **___** then **___**'), and it does not have a truth-value.

'If P then Q' - is a proposition (abbreviated) and it has a truth-value.

To repeat: 'P' and 'Indranil comes' are **propositional constants**. But 'p' 'q', 'r' etc are **propositional variables**.

Thus symbols that Logic uses for abbreviating propositional constants are explained.

10.2.3 Connective Constants and Logical Constants

Let us look into how Logic uses symbols for abbreviating other kinds of constants in language, which are *not* propositional constants. These other kinds of constants are **propositional connectives** - 'and', 'either or', 'if then', 'if and only if' , 'it is not the case that'. Apart from these propositional connectives there are quantifiers like 'All', 'Some, 'Few', 'A few' etc.

The connectives and quantifiers are also called ***Logical constants****, because they are the constant features of all language and all disciplines on which Logic can operate in a language–neutral and subject-neutral manner.* Though these ordinary language expressions are already short and wieldy, yet Logic uses further abbreviations, or a special set of symbols instead of these constants. Thus Logic uses -

'.' for 'and'

'v' for 'either or'

'⊃' for 'if then',

≡ for 'if and only if' ,

'~' for 'it is not the case that'

Now the forms of arguments (2) and (3) can be respectively symbolised as –

(2) p v q

~p

∴q

and

(3) p ⊃ q

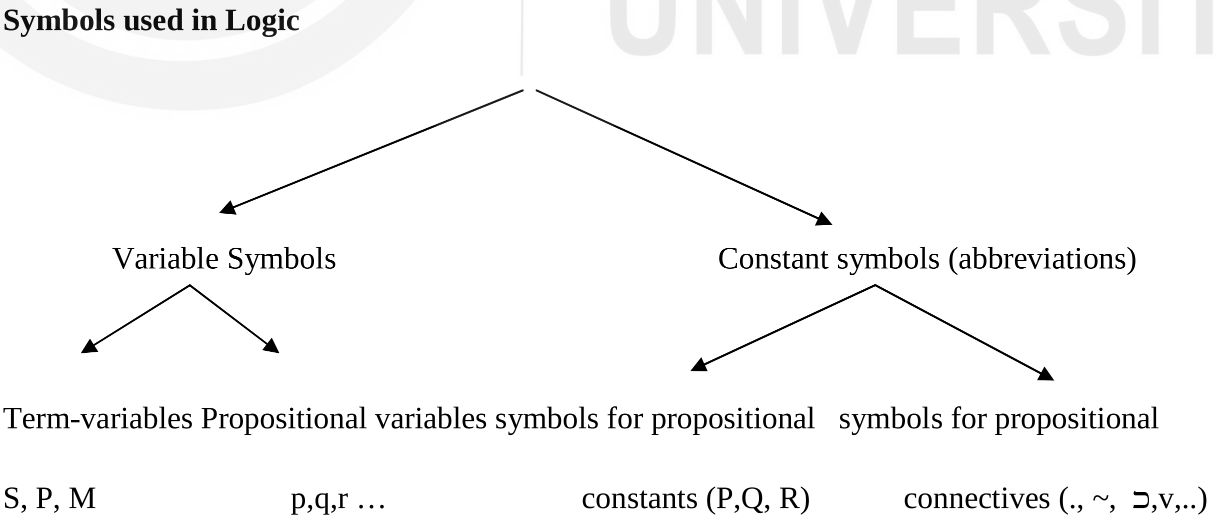
q ⊃ r

r ⊃ s

∴p ⊃ s.

We shall see that as Logic advances it has to use more and more special symbols for other kinds of constants as well – viz. for quantifiers, for predicate-terms as distinguished from subject-terms. The picture about Symbolic Logic that has emerged so far can be given in the following section.

10.2.4 Chart of Symbols used in Logic


Symbols used in Logic
Variable Symbols
Constant symbols (abbreviations)
Term-variables
S, P, M
Propositional variables
p,q,r …
symbols for propositional
constants (P,Q, R)
symbols for propositional
connectives (., ~, ⊃,v,..)

Please note that Aristotle, the founding father of Logic was also the first person to use variable symbols , viz. term-variables like S,P,M etc. and also propositional variables to a certain extent. *However he never used symbols for propositional connectives or for quantifiers.* Hence modern '**Symbolic Logic'** earns its name mainly from its extensive use of symbols.

Check Your Progress III

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. Distinguish between Variable symbol and Constant symbols.

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2.11 STATEMENT-FORMS OR PROPOSITIONAL FORMS

Once we understand the distinction between a propositional variable and a propositional constant it is easy to understand what a propositional form is. ***Propositional form*** *is a sequence of symbols which only contains propositional variables and no propositions (not even the abbreviations of propositions) so that when simple propositions are consistently substituted for each propositional variable, the result is a proposition.* Thus p, ~ p, p v q, p ⊃ q, etc. are all propositional forms.

There are three broad propositional forms – **Tautologous, Contradictory and Contingent**.

A propositional form is **tautologous** when whatever propositions are substituted as values of the propositional variables - the resultant proposition will always come true. Forms like p v ~p , (p. (p ⊃ q)) ɔ q are relevant illustrations.

A propositional form is **contradictory** when whatever propositions are substituted as values of the propositional variables - the resultant proposition will always come out to be false. Forms like p . ~p, (p. (p ⊃ q)) . ~ q are relevant illustrations. All propositions other than these kinds of two forms - say - p . q, ~p, p ⊃ q etc. are contingent, which means that their substitution-instances sometimes turn out to be true, sometimes false.

Check Your Progress IV

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. Distinguish among Tautologous, Contradictory and Contingent logical forms.

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2.12 ARGUMENT-FORMS

Argument-forms are a sequence of symbols containing logical constants and propositional variables, but no propositions, so that consistent substitution of simple propositions for each propositional variable results in an argument.

(Exercise: Apply this definition to p ⊃ q , q ⊃ r ,r ⊃ s∴p ⊃ s.

2.13 PROPOSITIONAL LOGIC VERSUS PREDICATE LOGIC OR QUANTIFICATIONAL LOGIC

Logic has to analyse arguments to display their characteristic forms of validity. Propositional Logic is confined to a special range of arguments, viz. those that do not need us to go beyond the simple propositions and lay out structure in which their component terms are arranged. Thus for propositional logic the ultimate terminus of analysis are simple or atomic propositions. Taking a look at the arguments used so far we can easily appreciate that demonstrating their validity needs some elements of the premisses to be repeated in the conclusion. For instance the way in which arguments 1, 2 and 3 become valid needs certain atomic propositions in the premisses to be repeated in the conclusion - in their entirety .This we have noted with respect to the form of argument 3 .

On the contrary look at this argument:

All teenagers are fun-loving

All Schoolchildren are teenagers

∴ All school children are fun loving

All the constituent propositions of this argument are atomic propositions in the sense that no part of these propositions is itself a proposition. To display the validity of this argument we need to show how the internal components or terms of each of these propositions are configured, and which terms re-appear in the conclusion. And for this we need to display the form of this argument by virtue of replacing each term by a term-variable - like S, P, and M. Thus comes up a different genre of Logic – viz. **Predicate logic** – which, in order to prove arguments to be valid or invalid has to split each atomic proposition into its constituent subject-term and predicate-term and also the quantifier like 'All' or 'Some'. Thus **Predicate Logic** is also termed as **Quantificational Logic. Propositional** logic, with its propositional mode of analysis, cannot display the **Quantity of a proposition – viz. whether the proposition states its predicate for all or some individuals.** Predicate logic with its sharper tools of analysis into the internal components of an atomic proposition is able to perform that task.

2.14 DIFFERENCE BETWEEN ARISTOTELIAN LOGIC AND PREDICATE-LOGIC OR QUANTIFICATIONAL LOGIC

Now although we can say that Aristotle's syllogism falls within the subject-matter of Predicate-logic or Quantificational Logic, there are at least two important reasons due to which Aristotelian Logic cannot be identified with **Predicate logic** or **Quantificational logic**.

Firstly, the latter uses a different mode of analysis than the Aristotelian model of division into S, P and M. This Logic invokes two variables – one for individuals without general properties, and the other for properties independent of any individuals. The symbols chosen for individual variable are x, y, z etc. and those chosen for property variables are F and G. Further symbols stipulated for abbreviating individual constants and predicate-constants are English alphabets – a, b, c etc., in the small case and in the capital case respectively. Thus **Predicate Logic** operates with an exclusive disjunction between subject (pure individual) and predicate (pure property) and hence significantly differs from **Aristotelian Logic.**

Symbols Used in Predicate-Logic or Quantificational Logic

Variable Symbols Constant -Symbols

Individual variables (x,y,z etc.) Quantifiers (x), (y) ,
Predicate-variables (F, G etc.) propositional connectives (., v, ⊃, ≡,)
Predicate Constants: A, B, C etc.
Individual constants: a, b, c, d, etc.

Secondly, Aristotelian mode of putting both a singular proposition (Ram is mortal) and a general proposition (All men are mortal) under an A proposition glosses over their mutual distinction. As **Predicate Logic** brings forth a finer dimension of quantity, viz. the quantitative distinction between an individual and general mode of predication, its alternative name of **Quantificational Logic** connotes a difference from the Aristotelian Logic.

2.15 FORMAL PROOF OF VALIDITY

It is clear that the task of Deductive Logic or Formal Logic is to improvise rules of inference by which it can move from one statement to another by the sheer formal power of these statements and not by their content. For example there must be a rule of conjunction by which we can move from p . q to q, there must be a rule of negation, conjunction and disjunction by which we can move from ~(p . q) to (~p v ~q), there must be a rule of implication which allows us to move from p ⊃ q and p, to q . Hence we can formulate the definition of the term '**formal proof of validity'** as – *a sequence of statements, each of which is either a premiss of a given argument, or follows from the preceding statements of the sequence by one of the rules of inference, where the last statement in the sequence is the conclusion of the argument whose validity is proved.*

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Check Your Progress V

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. How does Propositional Logic differ from Predicate Logic or Quantificational Logic?

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2. How is Aristotelian Logic different from Predicate Logic or Quantificational Logic?

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2.16 FALLACIES

With each form of a valid argument there will be a corresponding form of invalidity. E.g. corresponding to the valid form viz. $(p \supset q)$. p ∴q there will be an invalid form viz. $(p \supset q)$. q ∴p. Formal fallacies would be flaws that one would incur in moving from one proposition to another on the basis of an invalid argument form or an invalid rule of inference. Thus affirming the antecedent on the basis of affirming the consequent is a kind of fallacy.

2.17 INDIAN LOGIC

Indian Logic does not only deal with the rules of evaluating arguments, but also with the rules of attaining valid cognition of the premisses. Thus it is concerned with the full fledged cognitive process of inference and not simply the bare formal structure. Thus Indian Logic does not make the distinction between induction and deduction, or between form or content of arguments

2.17.1 Anumāna and Anumiti

Both *Anumāna* and *Anumiti* pertain to the cognitive process of inference**.** The special means employed for attaining as inferential cognition is called *anumāna*. The cognition that results from the employment of the special means is called *anumiti*.

2.17.2 Constituents of an Anumāna: Hetu, Sādhya, and Pakşa

In an inference there is always an entity of which something is predicated on the strength of some other thing.

The entity of which something is predicated is called the subject or ***pakşa****.*

The something that is predicated of the pakşa is called the probandum or the ***sādhya****.*

The thing on the strength on which the predication is performed is known is called the probans or mark or ***hetu*** *of the inference.*

The stock example of an is *anumiti* is - This hill has fire, because wherever there is smoke there is fire, and this hill has smoke that is pervaded by fire. Evidently what figures as the pakşa, *sādhya* and *hetu* in the above example are the hill, the fire and the smoke respectively. (One can also easily see that they roughly correspond to what is signified by the minor term, major term and the middle term of the western syllogism.)

2.17.3 Anumāna or Parāmarśa

The special means or the *anumāna* for acquiring *anumiti* is a special kind of cognition viz. ***Parāmarśa***. Roughly speaking, in any inference we see a site characterised by a mark or a hetu – say a hill emitting smoke, followed by a remembrance of the universal co-presence of smoke and fire, further followed by the assurance that the smoke that we see comes under this universal rule. It is this assurance that is the *parāmarśa*. *To it more formally, it is the cognition of the subject (pakşa) of an inference, having a mark (hetu) that in its turn is universally pervaded by the sādhya or the property to be inferred.* This *parāmarśa* or application comes last in the series of cognitions, immediately generating the final inferential cognition viz. 'The hill has fire'; and hence it is called the instrumental cause of inferential cognition.

2.17.4 Svārthānumāna and Parārthānumāna

Inferences are generally of two types – *inference for oneself* (***svārthānumāna*****) and** inference for others (***parārthānumāna*****).** The above account applies to the first kind, where a person applies a *hetu* in a particular site to gain some new knowledge for his own purpose (*svārtha*). On the other hand the person may also adopt a special means to bring about an inferential cognition for others (*parārtha*).

2.17.5 Parārthānumāna or the Five Membered Syllogism

On the occasions of *parārthānumāna* the speaker employs a compound statement consisting of five components to produce the required inferential cognition for his hearer. For the stock example of inference from smoke to fire these five statements will be:

(i) There is fire in the hill, (*Pratijñā* or Thesis)

(ii) Because there is smoke (*Hetu* or the Reason)

(iii) Wherever there is smoke there is fire (as in kitchen etc.) (*Udāharaṇa* or the statement of *vyāpti* with examples)

(iv) The hill has smoke which is pervaded by fire (*Upanaya* or Application)

(v) Therefore the hill has fire (*Nigamana* or Conclusion)

The Naiyāyikas hold that it is the cognition generated by this five-membered statement in the form of a *parāmarśa* that is the penultimate stage in generating the inferential cognition in the mind of the hearer, and hence that *parāmarśa* again is the *parārthānumana* in the primary sense of the term.

2.17.6 Vyāpti

In order to ensure that the inference is a correct one the *hetu* employed has to be valid. To be valid, the *hetu* has to be universally and unexceptionally pervaded by the *sādhya*, so that one can legitimately say: 'Wherever there is *hetu* there is the *sādhya*'. This required relation between the *hetu* and *sādhya* is called *vyāpti* or the rule of Concomitance.

Here the qualification of the *vyāpti*-relation pertains to the *sādhya* – the *sādhya* must be such that it must never be absent where the *hetu* is present, (though the reverse might not always hold true.) The *hetu* or smoke is absent in some locations of fire (viz. the red hot iron ball) which shows that the *sādhya* is not pervaded by the *hetu*.

2.17.7 Hetvābhāsa

The term 'hetvābhāsa' is a compound of two terms: 'hetu' and 'ābhāsa' i.e. the appearance or a fault. The term 'hetvābhāsa' thus stands for an apparent or seeming mark, or the folly of the proposed mark. 'Hetvābhāsa' is defined as *that whose correct cognition is an impediment to an inference.*

Example: Sādharaṇa Savyabhicāra is a type of Hetvābhāsa. A faulty hetu of this type is defined as one which is present where the sādhya is absent.

For instance: This hill has fire

Because it is knowable

Here hill is the *pakşa*, fire is the *sādhya*, and knowability is the *hetu*. The *hetu* is not only present in the items like kitchen, cowshed, factory, where the *sādhya* is present, but also in the sites where the *sādhya* is absent - like lakes, ponds, ice-refrigerator etc. The *hetu* is not present exclusively where the *sādhya* is, and thus impedes the correct cognition of *vyāpti* between knowability and firehood.

Check Your Progress VI

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. Distinguish between Svārthānumāna and Parārthānumāna in Nyaya Logic.

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2.18 LET US SUM UP

Focusing on the notion of arguments and the propositions that constitute arguments we have browsed through all the basic notion of deductive logic. The use of symbols designed to uphold the logical form of propositions and arguments, furnishing a key to the techniques of applying formal proofs of validity have been clarified. Lastly the basic notions and vocabulary of Indian Logic have also been presented – to provide a more comprehensive grasp of Logic.

2.19 KEY WORDS

Argument-Form: is a sequence of symbols containing logical constants and propositional variables, but no propositions, so that consistent substitution of simple propositions for each propositional variable results in an argument.

Categorical propositions: are those which make statements irrespective of any condition.

Conditional proposition: makes a statement as qualified by some condition.

Formal Proof: a sequence of statements, each of which is either a premiss of a given argument, or follows from the preceding statements of the sequence by one of the rules of inference, where the last statement in the sequence is the conclusion of the argument whose validity is proved.

Hetvābhasa: an apparent or seeming mark, or the folly of the proposed mark.

Immediate Inferences: are those where the conclusion is claimed to follow from a single premiss.

Inference: Inference is a cognitive process which addresses the sequence through which the knowledge of the premisses leads to that of the conclusion.

Mediate Inferences: are those that have more than one premiss to entail the conclusion.

Parāmarśa: the assurance that the *hetu* that we see comes under *vyāpti*.

Propositional form: is a sequence of symbols which only contains propositional variables and no propositions (not even the abbreviations of propositions) so that when simple propositions are consistently substituted for each propositional variable, the result is a proposition.

2.20 FURTHER READINGS AND REFERENCES

- Copi I. M., and Cohen C, (ed.) 2004, *Introduction to Logic*, Prentice Hall of India Pvt Ltd., Delhi.
- Copi, I.M, Cohen, C, McMohan K (ed.) 2016, *Introduction to Logic*, Pearson, Delhi, Chennai. (for the chapter on Indian Logic)
- Hurley, P. (2014). *A Concise Introduction to Logic* (12th Revised edition), (Chapters 6, 7, 8), Wadsworth Publishing Co Inc.

2.21 ANSWERS TO CHECK YOUR PROGRESS

(Learners are advised to substantiate their answers by using their own illustrations and examples, wherever applicable.)

Check Your Progress I

1. **Hint-** sentences are not constituents of an argument, whereas propositions are the constituents of an argument; Sentences are physical objects consisting of visible signs or audible sounds; Meanings of declarative sentences enter into the constituents of arguments. (Sec. 2.4)

Check Your Progress II

1. **Hint-** Immediate Inferences are those where the conclusion is claimed to follow from a single premiss.

Mediate Inferences are those that have more than one premiss to entail the conclusion.

(Sec. 2.9.4)

Check Your Progress III

1. **Hint-** Variable symbols are certain place-markers that take in specific kinds of values in its space.

Constants unlike variables are not place-markers, they do not take in values.

(Sec. 2.10.2)

Check Your Progress IV

1. **Hint:** In a Tautologous propositional form all instances of the resultant proposition turn out to be true.

In a contradictory propositional form all instances of the resultant proposition turn out to be false.

In a contingent Propositional form some instances of the resultant proposition turn out to be true and some instances of the resultant proposition turn out to be false. (Sec. 2.11)

Check Your Progress V

1. Hint: Propositional logic cannot display the Quantity of a proposition, whereas Predicate logic is able to perform that task. (Sec. 2.13)

2. **Hint:** Predicate logic uses a different mode of analysis than the Aristotelian model of division into S, P and M.

Aristotelian mode of putting both a singular proposition and a general proposition under an “A” proposition glosses over their mutual distinction.

(Sec. 2.14)

Check Your Progress VI

1. **Hint:** inference for oneself (svārthānumāna) and inference for others (parārthānumāna).

On the occasions of *parārthānumāna* the speaker employs a compound statement consisting of five components to produce the required inferential cognition for his hearer.

(Sec. 2.17.4 and 2.17.5)

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UNIT-3 INDUCTIVE AND DEDUCTIVE LOGIC[*]

Structure

3.0 Objectives

3.1 Introduction

3.2 Deductive reasoning

3.3 Inductive reasoning

3.4 Relation between two types of reasoning

3.5 Arguments against deductive and inductive reasoning

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3.7 Indian Logicians' view on types of reasoning

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3.9 Key Words

3.10 Further Readings and References

3.11 Answers to Check Your Progress

3.0 OBJECTIVES

This unit titled *Inductive and Deductive Logic* aims at familiarizing you with nature and scope of deductive logic (formal logic) and inductive logic (material logic). Logic, traditionally, has been divided in into two types; deductive and inductive. This unit will elaborate on intricate features of these two types of logical reasoning. By the end of this unit you will learn:

- The role played by reasoning and inference in the development of logic.

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- The distinction and connection between two types of reasoning process.
- Distinction between universalization and generalization.
- Different types of inductions.

3.1 INTRODUCTION

Logic is the science of reasoning. Logic as a discipline trains a person in certain methods, devices, tools and techniques that help in differentiating right reasoning from wrong ones. Reason/Reasoning is used to form inferences; conclusions drawn from propositions or assumptions that are supposed to be true. A piece of reasoning involves argument that is a relational arrangement of premises (evidences, facts, assumptions) and conclusion. As there are more than one ways to start with information and arrive at a conclusion; thus, there are more than one ways to reason. Each has its own strengths, weaknesses, and applicability to the real world. Depending on the type of logical relationship (probable or necessary) between premises and conclusion, there are two forms of reasoning- inductive and deductive and corresponding two types of logic. Inductive logic deals with inductive arguments and deductive logic deals with deductive arguments. Though the nature of reasoning in both of them is not same, their aim is same. Both inductive and deductive logic provide methods and criterion to differentiate correct reasoning from incorrect ones. Deductive reasoning is the process in which conclusions are drawn with logical certainty from given premises. This type of reasoning is used in mathematical proofs or when dealing with formal systems.

In inductive reasoning one draws the “best” conclusion suggested by the set of observations/ experiential statements. Here observations used as evidence are always incomplete and insufficient to support a definitive conclusion, therefore one can never be certain of the conclusions one makes. This process is analogous to the scientific process in general. From the above discussion it can be observed that logic is a discipline of study to learn how to reason well. Meanwhile, reasoning is the mental process used to draw inferences from certain assumptions, beliefs, facts or observations; and arguments are the structural arrangement of content of thought process (premises and conclusion). Due to this intimate connection of meanings, one may find, these terms *logic, inference, argument* and *reasoning* are quite often used interchangeably while explaining induction and deduction. To understand the nature and scope of inductive and deductive logic, we shall now look at the intricate features of two forms of reasoning at length in the following sections.

3.2 DEDUCTIVE REASONING

In deductive reasoning the relation between premises and conclusion is of necessity i.e. conclusion necessarily follows from premises. In other words, premises offer *conclusive ground* for conclusion. *Conclusive ground* means evidences are complete and sufficient enough to support the conclusion. Acceptance of premises leaves no room for any reasonable or meaningful doubt about acceptance of conclusion.

Let us take an example:

Argument 1: P1: All men are mortal

P2: Mahatma Gandhi is a man

C: Therefore, Mahatma Gandhi is mortal

The conclusion "Mahatma Gandhi is mortal" is already contained in the premises. What is already contained in the premises in implicit form, reasoning just makes it explicit in conclusion. There is no novelty. No new information is given in the conclusion. So, in any valid deductive argument it can never be the case that false conclusion is drawn from all true premises. If we have assumed something to be *true* in premises, how can it be opposite i.e. *false* in conclusion? It is a contradiction in itself. In deductive reasoning, we don't go beyond what is stated in the set of premises.

Deductive Reasoning provides necessary and certain knowledge: One may even wonder that if the conclusion does not go beyond premises and no new information is acquired in the process, then what the significance of deductive arguments is. This curiosity finds its answer in understanding the point that *knowledge is not mere acquisition of new information.* Knowledge is the outcome of critical, reflective and analytical attitude. There is an ancient Indian saying: *eliminate ignorance (avidya) and become enlightened*. Deductive argument helps us to know what is imbedded in the premises. It is an expedition into the analysis of the meaning of the premises. We analyze and reflect on the information provided in the premises and form connections between different aspects. And then what's already there in implicit form, stated out in conclusion explicitly. We can comprehend now, why the denial of conclusion in such a case amounts to denying the meaning of the premises which were accepted earlier. Therefore, we say that a valid deductive argument is characterized by logical necessity. An argument is valid if its premises necessarily imply its conclusion, otherwise it becomes invalid. In a valid deductive argument, conclusion is either equal to the premises or less than them, but never states anything which goes beyond or wider than information given in premises.

Moreover, addition of more information to premises does not affect the conclusion of valid deductive argument. In the above cited argument any further addition to the already given set of premises, for instance adding "Mahatma Gandhi preached Non-violence and Truth", "Mahatma Gandhi was the author of Hind Swaraj" etc. makes no difference to the conclusion. Given set of premises (P1 and P2) in the above argument are complete, sufficient, proper to entail conclusion (C). A valid argument cannot become more valid in virtue of addition of one or more premises. On the other hand, if any one or more premises are taken out of a valid argument, then the argument does not become 'less valid', it simply becomes 'invalid'. Subtraction of premise from argument changes the status of argument straight away from valid to invalid. So, a deductive argument is either valid or invalid. Validity is not a matter of degree. Differences between valid and invalid arguments are only in kind. The premises in a valid argument constitute necessary and sufficient conditions to accept the conclusion. An argument is invalid due to a 'missing link' in the class of premises.

Formal character of the deductive argument: One of the significant features of deductive logic is its formal character. It puts emphasis upon the structure and form of an argument. Form or structure of the argument is order, pattern, arrangement in which all the elements (terms and propositions) stand in relation to one another. Form is the only deciding factor in assessing the validity/invalidity of deductive arguments. In inductive logic matter or content is of primary importance. When we deal with the form of deductive argument, we also deal with 'validity' and 'invalidity', on the one hand, and 'truth' and 'falsity' on the other. Only propositions are evaluated as true or false whereas deductive arguments are evaluated as valid or invalid.

We generally think that a combination of true statements will lead to valid argument and false to invalid, but this is not the case. It means that truth and validity may or may not coincide with each other. Structure of the argument plays an important role in deciding validity and invalidity of argument. There is a distinction between material truth and logical truth. Material truth is what is stated by matter of fact. Logical truth is the outcome of the form of argument. A deductive logician does not question the status of premises. It does not matter to him or bother him if the premises are actually true or not. He merely checks what necessarily follows from the given set of premises. He does not do empirical enquiry. In deductive reasoning one assumes premises to be true (irrespective of their actual/material truth value) and then arranges them in such a manner that conclusion necessarily follows from them.

All possible combinations of the connection between truth- falsity of the statements of the argument and validity- invalidity of that argument can be summarized as shown in the table below. (Reason with examples for each case shall be explained at length in the next unit *Truth and Validity*. It has been discussed here in brief to make you appreciate and comprehend the formal nature of deductive reasoning.)

	Premises	Conclusion	Arguments
1	TRUE	TRUE	VALID
2	TRUE	TRUE	INVALID
3	**TRUE**	**FALSE**	**INVALID**
4	FALSE	TRUE	VALID
5	FALSE	TRUE	INVALID
6	FALSE	FALSE	VALID
7	FALSE	FALSE	INVALID

Table 1: Relation between Truth and Validity

Through this table we can observe that:

a) A valid argument (1, 4 and 6) may consist of a true premise with true conclusion (1) or false premise with false conclusion (6) or false premise and true conclusion (4).

b) An invalid argument (2, 5 and 7), similarly, may consist of statements in exactly the same manner as mentioned above. It may consist of a true premise with true conclusion (2) or false premise with false conclusion (7) or false premise and true conclusion (5).

c) Case-3 points out towards the logical necessity associated with deductive reasoning. In any valid deductive argument false conclusions cannot be drawn from all true premises. In this case, necessity is of a particular kind, i.e. logical necessity. We have already mentioned this point in previous paragraphs as a significant aspect of deductive reasoning. An argument is called sound if it is valid and the premises are materially true.

From the above combinations it is clear that even with all false propositions one can give a valid argument and with all true propositions an invalid argument. The point to note here is that validity and invalidity are formal notions and hence applied to formal reasoning or formal logic only.

Deductive logic like mathematics is a formal science. The arguments in deductive or formal logic are categorized into different classes according to the general form/structure they possess. Arguments having the same form are treated in the same manner even if the content of each argument is different. The logicians search for formal similarity among the arguments. For example, argument 2 and argument 3 given below have the same form though the content is different.

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Argument 2

P1: All Mathematicians are Logicians.	All x are y.
P2: Some Mathematicians are Scientists.	Some x are z.
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C: Therefore, Some logicians are scientists.	∴ Some y are z.

Argument 3

P1: All Philosophers are writers.	All x are y.
P2: Some Philosophers are poets.	Some x are z.
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C: Therefore, Some writers are poets.	∴ Some y are z.

We can observe clearly that the structure of these two arguments (argument 2 and 3) is identical. The difference consists in subject matter only and it is possible to construct numerous arguments having the same structure as argument 2 and argument 3. The essence of formal logic consists in saying that P1 & P2 imply C. Only implication and entailment are relevant here. Strawson has made it clear that *implication or entailment is independent of subject matter.*

The logical principles or rules that are used to determine correctness (validity) and incorrectness (invalidity) of an argument are formulated on the basis of common logical features of the argument. Thus, the logical form of an argument is the most precious thing in logic. If the form of the argument gives a valid argument, then any argument which has the same form as that argument will be valid irrespective of the content of the argument or material truth of the statements used to form that argument. The formal logicians frame rules and formulae for testing the validity of arguments on the basis of logical form they possess. If there have been separate rules for each argument, then testing validity/ invalidity of argument would have become a cumbersome task. The representative formulae or the general rules of argument do not disagree with each other. They are connected and thus provide an ideal and organic system of logic.

Above description can be further clarified with the help of concepts of *constants* and *variables*. Let us represent terms used in the above two arguments by 'x', 'y' and 'z'. Represent the terms 'Mathematicians' and 'Philosophers' with 'x', 'Logicians' and 'Writers' with 'y' and 'Scientists' and 'Poets' with 'z'. Representative/symbolic form is shown on the right hand side of the respective arguments (argument 2 and argument 3). In this particular framework, without knowing the contents of 'x', 'y', and 'z' we can know that 'P1 and P2 together imply/ entail/leads to C'. The same explanation holds good for any invalid or inconsistent argument where premises do not imply conclusion.

Such forms are called logical forms. A logical form has two components: variables and constants x, y, z etc. in above examples are variables. Quantifiers like 'All', 'Some' and logical connectors/ operators like 'if ……. then', 'either…or', 'and', 'not' and 'if and only if' are called logical constants. In the final analysis, the structure of an argument is determined by constants, and not by variables. Every class of argument has fixed constants. The structure of one class of arguments is different from the structure of some other class of arguments. When the structure of an argument differs, the laws also differ.

Over centuries, logicians devised powerful techniques to discriminate valid arguments from invalid one. Though the traditional techniques and methods for determining validity differ from those used by modern logicians, the fundamental task is the same. To name few 'six rules of valid categorical syllogism', 'Venn diagram method', 'nine rules of inference', 'ten rules of replacement', 'truth table method', 'shorter truth table (*reductio ad absurdum*)' are some techniques discussed in deductive logic to check validity/invalidity of an argument or to construct formal proof of validity. Predicate calculus was introduced to make the internal structure of propositions more clear. It deals with forms of arguments which, on account of their complexity, are beyond the scope of propositional calculus.

The form or structures of argument and rules used to determine validity (invalidity) are mutually dependent. If it is possible to decide the structure of an argument and also different classes of arguments, then it is possible to achieve what is called formalization or systematization. So, *generality, form* and *system* are three features of formal logic.

Deductive logic provides a priori knowledge: We have observed in above discussions that like Mathematics, Logic is formal Science. It deals with relations which are applicable to actual as well as possible objects. It is deductive in character. Another similarity is that method of both is a priori i.e., independent of experience. Deductive arguments are like analytic statements. Knowledge obtained from an analytic statement is necessarily a priori, i.e. knowledge prior to sense experience. In analytic statements the predicate term is contained in the subject term. For example in the statement "All bachelors are unmarried" the term 'unmarried' is already contained in the subject 'bachelor'. In deductive argument, conclusion is contained in the premises. Deductive logic provides knowledge a priori, though the premises and conclusion considered separately are not analytic. Let us explain it with the help of an example:

Argument 4: P1: All businessmen are wealthy people.
P2: All wealthy people are philanthropists

C: Therefore, all businessmen are philanthropists.

Evidently, there is no need to examine businessmen and wealthy people to know that the conclusion is true. Indeed, it is not even necessary that there should be businessmen who are wealthy as well as philanthropists. This being the case, argument takes the following form without leading to distortion of meaning.

"If all businessmen are wealthy people and all wealthy people are philanthropists, then all businessmen are philanthropists."

The argument is transformed into a statement which involves relations. All hypothetical or implicative relations (the present relation is of one such kind) are such that without the help of sense experience, but only with the laws of formal logic, it is possible to derive a conclusion. Thus like an analytic statement, any valid deductive argument provides a priori knowledge and hence it is devoid of novelty. Here sense experience takes back seat and intellect or reason becomes the prime means of acquiring knowledge. Following the footsteps of Descartes, who is regarded as the father of rationalism, we can conclude that deductive logic is rational. So we have sketched three characteristics of deductive reasoning: logical necessity, a priori and rational.

But sometimes the conclusion of an argument does not stand in such a necessary relation with premises. Quite often in our daily dealings we use non- deductive reasoning. Doctor's diagnosis of the patient for finding the root cause of his/her illness is done in a non-deductive manner. Even legal experts/lawyers use inductive methods to decide what law governs in a particular case. Inductive arguments are tentative, probable, and provisional. No empirical science, natural or social, which aims to describe nature, world, or society, can do without induction. Let us now look at inductive reasoning in detail.

Check Your Progress I

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. Analyze the relation between validity and formal character of deductive arguments.

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3.3 INDUCTIVE REASONING

In inductive reasoning, conclusion is drawn on the basis of some observed instances. This type of argument begins with sense experience. The premises of inductive argument are statements which directly result from sense-experience. However, the conclusion is not an observational statement i.e. its material truth is not known. In inductive reasoning, though the premises do not imply the conclusion with certainty, yet the premises give good reasons that suggest a particular conclusion. Contrast to the deductive reasoning, conclusion of an inductive argument doesn't get implied or entailed by the premises. Therefore, inductive reasoning does not provide a necessarily true and certain knowledge. The evidences (premises) only support the conclusion and do not entail it. Let us take an example of inductive argument:

Argument 5: P1: Professor x is a writer and he is wealthy.
P2: Professor y is a writer and he is wealthy.
P3: ………………………………..
P : multiple observations of the same kind
Pn: …………………………………..

Therefore, All professors who are writers are wealthy.

No matter how many observations we have, as stated in premises P1, P2...Pn, they cannot prove the conclusion 'All professors who are writers are wealthy.' The premises offer, at best, reasonable grounds to 'believe' in such a conclusion. However, 'belief' is not the same as proof. The statement 'All professors who are writers are wealthy' not only includes observed cases of Professors who are writers and wealthy, but also includes unobserved cases (of past and future). It is this component of unobserved cases and the leap taken in conclusion that is the root cause of endless debate on the nature of inductive inference. Uncertainty and sense experience characterize any inductive argument. Aristotle used the word 'epagoge' for 'induction' and C.S.

Peirce called them ‘ampliative’, as in this type of argument the conclusion always goes beyond the premises.

There is nothing contradictory in accepting all true premises and a false conclusion in inductive/non- deductive arguments. In the above example all the premises are true but the conclusion is only probable or may turn out to be false later on, and still it is not contradictory to accept it. If someday one comes across a professor who is a writer but not wealthy, this evidence will change the status of the above argument completely.

In deductive reasoning, it is impossible to deny the conclusion, when the premises are accepted as true, without contradicting itself. But inductive arguments escape from this contradiction. The reason is that the conclusion includes more information than the premises. After accepting the premises if we deny the conclusion, we deny only that component of the conclusion which does not coincide with the premises. Therefore, denial does not imply contradiction.

Let us take one more example here which has same form as argument 5 but is more appealing and strong:

Argument 6: P1: Crow X is black.
P2: Crow Y is black.
P3: ……………………………
P : multiple observations of the same kind
Pn: …………………………………
C: Therefore, All crows are black.

In this kind of argument one can never be sure that all crows are black in colour. It is possible that in future one may come across a crow which is not black in colour. Since one can not rule out this future possibility and the leap is taken in the conclusion on the basis of limited observations of the past and present, the conclusion is only probable not certain. Though argument 5 and argument 6 have same form with different content, argument 4 appears weaker and argument 6 to be stronger in drawing respective conclusions. In case of deductive reasoning arguments with the same form share the same truth value (both valid or both invalid) but in inductive reasoning depending on the content arguments with the same form have different strengths.

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Logical form of two inductive arguments given above is as follows:

P1: The element x1 of the set A has the property B.
P2: The element x2 of the set A has the property B.
P3: ……………………….
P : multiple observations of the same kind
Pn: The element xn of the set A has the property B.

C: Therefore, all the elements of the set A have the property B.

The results of inductive reasoning are only probable. Inductive arguments are not evaluated as valid or invalid. The relation between evidences and conclusion is not of necessity but rather of suggestion. Probability is a matter of degree. Assume that ‘truth’ takes value ‘1’ and ‘falsity’ takes value ‘0’. Then the numerical value of probability of conclusion varies from 0 to 1 without reaching either lower limit or upper limit. The favorable premises raise the probability value of conclusion, making the inductive argument strong. Addition of premises may change the status of argument from inductive to deductive, if on probability scale it becomes 0 (false) making argument invalid or 1 (true) making augment valid. Therefore, an inductive argument may consist of any number of premises, but what makes an argument more acceptable (strong) or less acceptable (weak) is the probability value that it takes. An inductive argument is evaluated by degrees such as weaker or stronger, appealing or non- appealing, convincing or non - convincing, etc. depending on the strength of evidences. A strong inductive argument with true premises is called a cogent inductive argument.

Here, it is necessary to remove a misconception regarding inductive arguments. It is held erroneously that inductive argument proceeds from particular premises to universal conclusion. Arguments 5, argument 6 and arguments with similar forms may also give this impression. Sometimes a distinction between inductive and deductive argument is also made on the same line. Deductive inferences are considered to go from general/ universal premises to the particular conclusion and inductive arguments from particular premises to general/ universal conclusion. But this is not always true. The conclusion of an inductive argument may or may not be in the form of universal statement but yes it is always based on some kind of generalization. In deductive arguments, the conclusion may or may not be a particular statement but it is true that premises always have one or more universal/ general statements. The error and misconception arise due to confusing universal statements with generalization. A universal

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statement differs from generalization because a universal statement can be constructed within the limits of sense experience without involving generalization (which goes beyond sense experience). For example, when a teacher concludes after checking all the answer scripts of a class that every student of that class scored above 80 marks, the conclusion is a universal statement. But it is not an instance of generalization, because there is no leap from observed to unobserved or unobservable.

To make the above point more clear let us take one example of each; deductive and inductive reasoning where this dichotomy (that is, in deductive inferences particular conclusion is drawn from universal/ general premises and in induction universal/ general conclusion is drawn from particular premises) does not fit.

Argument 7: P1: All rectangles are quadrilaterals.
P2: All squares are rectangles.

C: Therefore, All squares are quadrilaterals.

Argument 7 is a valid deductive argument, where universal conclusion is inferred from universal premises.

Argument 8:

In a law court, a case of murder was presented in front of Judge. Mr. *X* was charged for murdering Mr. *Y*. The argument which was given against Mr. *X* was formed on the basis of following evidences:

> Mr. *X* and Mr. *Y* were business partners for 23 years but things were not going well between them for the past 2 years. They had a dispute over a property which they purchased jointly. *X* was also not happy about a business deal which *Y* finalized without taking *X's* consent. Mr. *X* was seen in Mr. *Y's* office two days before *Y's* murder. On that day, Mr. *Y's* office staff heard Mr. *X* threatening and forcing *Y* to sign property papers. In police investigation Mr. *X's* fingerprints are also found on the weapon obtained from murder site.

These evidences strongly suggest that Mr. *X* murdered Mr. *Y*.

In the above inductive argument we moved from particular premises to particular conclusion.

What inductive reasoning provides in conclusion is merely a statement which depends upon experience, but in itself is not an experiential statement. No one has seen Mr. *X* murdering Mr. *Y*, but this conclusion is drawn with high probability based on the available evidences.

In some cases, experience can vouch for the conclusion, but in some other cases, it cannot. In inductive reasoning, conclusion is characterized by a sort of leap, leap from 'observed to unobserved/unobservable'. This is known as 'inductive leap' which always leads to generalization. Induction cannot even be conceived in the absence of generalization. In the above example also some generalizations are made. There is progress from particular observations to generalized statements (past experiences of similar situations where somebody murdered the other due to disputes, murderer fingerprint found on weapon lead to form generalization about all similar cases) and from them to particular conclusion. So generalization is used to reach this conclusion.

In Inductive inference both form and matter of an argument play a role in evaluation of its status. But more than structure of argument, the subject matter is relevant. The acceptability or relevance of the conclusion varies from one argument to another. Further, adding and subtracting some information from premises affect the conclusion of the inductive argument. It becomes strong or weak or changes its type from inductive to deductive on adding some more information. Addition of any future observation which contradicts previous observations will change the nature of inductive argument to deductive. Addition of this information that 'Mr. X was not in the city on the day Mr. Y was murdered' will change the status of the argument. Or availability of CCTV footage which shows presence of some other person on murder site will make argument weaker.

Consider one more example where inductive reasoning is used but is different in form from previous argument:

In the outbreak of Covid19 in 2019-2020 all over the world, people were made aware about the bodily symptoms of corona disease and advised to follow the prescribed guidelines to stop the further spread of disease. On observation of multiple corona patients few symptoms were considered to be pointing out towards the presence of Corona disease. It had been observed that most people who were detected with Corona virus and hospitalized for its treatment had symptoms like high body temperature (fever), dry cough, loss of smell or taste or both, shortness of breath, mucus or phlegm, congestion or runny nose. So here on the basis of multiple observations a generalized conclusion is drawn about the presence of Corona virus in a person with above symptoms.

But later on different cases also came into picture where people who had no such symptoms were also found suffering with Corona and people who had some of the above symptoms were not detected with Corona. So, the presence of some symptoms or absence of them gave no certainty about drawing this conclusion that somebody is Corona positive or Corona negative. Unless and until that person's lab test is done, it is only a matter of speculation. This kind of reasoning is inductive in nature; we merely speculate something based on available evidences. Inductive arguments which appear to be strong at one point of time may lose their strength with addition of more observations which do not agree with previous observations.

This analysis makes two points clear. Content alters the acceptability of inductive argument and they are neither valid nor invalid. In other words, an inductive conclusion is neither true nor false. At best it is probable and at worst it is improbable.

In inductive arguments the relation between premises and conclusion is like 'synthetic' statements where the meanings of subject and predicate are different, but otherwise related as in the case of the statement, 'The table in the dining area is round'. Synthetic sentences are descriptions of the world that cannot be taken for granted. It is possible to ascertain the truth or falsity of such proposition, but it is not possible to know it before sense experience.

Some cases of inferences are future-oriented and in principle 'verifiable'. However, inductive inference need not be so always. It can also be past-oriented which is surely, 'unverifiable'. History, anthropology, geology, etc. consist of arguments which are past-oriented. But the mechanism involved in both the cases is exactly the same. Therefore, the prime characteristic of induction is that the conclusion does not necessarily follow from the premises and that experience precedes inference which means that inductive inference is uncertain and *a* *posteriori*. Whatever knowledge we acquire 'after experience', or whatever depends upon experience is called *a posteriori* as opposed to *a priori*.

So inductive reasoning is synthetic, a posteriori, reason- based and has been used in natural and empirical sciences.

Check Your Progress II

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. Explain briefly the characteristics of inductive reasoning.

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3.4 RELATION BETWEEN TWO TYPES OF REASONINGS

It is not correct to consider deduction and induction as opposed, antithetical or contradictory to each other. They are rather complementary and supplementary to one another. The relation between deductive and inductive reasoning is more like team mates in a race. One type of reasoning should not be considered to be more fundamental than the other. Deduction begins where induction ends. The conclusion of inductive reasoning may serve as a premise for deductive reasoning. They differ only in their 'beginning points'.

Just as deductive logic has affinity with mathematics, inductive logic has affinity with the methods employed by the scientists. But to think that empirical sciences whether natural or social are purely inductive is not correct. The deductive reasoning also occurs in empirical sciences. If you look closely at argument 8 discussed above deductive reasoning followed up after inductive reasoning Arthur in his *An Introduction to Philosophy of Science* says "there is no other way of testing an empirical hypothesis- especially one of highly theoretical character, such as the hypothesis of universal gravitation, or the atomic hypothesis- than by deducing from it directly testable consequences." (Arthur, P139)

3.5 ARGUMENTS AGAINST INDUCTIVE AND DEDUCTIVE REASONING

Hume says there are two possible types of arguments, “demonstrative” (equated with deductive) and “probable” (equated with inductive), but neither of them serve to draw some conclusion without fallacy. A demonstrative argument produces the wrong kind of conclusion, and a probable argument would be circular.

There are fewer criticisms raised against deductive arguments as compared to inductive arguments. One criticism that has been raised was by J. S. Mill against one type of deductive argument- syllogism (arguments with exactly two premises). In general, this is applicable to any deductive argument. Mill contends that syllogism just repeats the premises in the conclusion without going any further i.e. syllogisms are circular or non-ampliative and thus trivial. Mill claims that all attributes (terms, premises, and conclusion) are logically independent. Here, if we refer to argument -1 discussed above (All men are mortal, Mahatma Gandhi is a man. Therefore, Mahatma Gandhi is mortal.), Mill’s claim says that the truth of the major premise adds nothing to the truth of the particular propositions, ‘this man is mortal,’ ‘that man is mortal’, etc., whose conjunction it records. Accepting the major premise as true is simply a way, on the one hand, of accepting that particulars, one already knows, share the attributes in question (mortality), and, on the other hand, a determination that one will continue to affirm this connection of hitherto unexamined particulars. Deductive logic or syllogism adds nothing to our knowledge. The rules of formal logic, of syllogistic logic, are the rules of logic of consistency. We referred to this problem of novelty in 3.2, and also saw a powerful response to this objection.

But the objections raised against induction are more severe. The challenge for the empiricist is how to get universality and generality, necessity, and normativity out of particular, contingent experiences.

At first, inductive reasoning is not regarded as logical at all since in inductive arguments the truth of the conclusion does not necessarily follow from the truth of premises. This objection can be met by arguing that deductive standards need not to be applied to inductive logic, lest the distinction itself becomes superfluous.

Hume demonstrated that deduction cannot be used to explicitly prove the truth value of an inductive inference. The inductive inference to be proved must be taken as an axiom, thereby leading to circular logic between the premise and conclusion. Thus, inductive inferences are open-ended, and acting upon them requires faith that no contradictory case will eventually appear. Hume showed that we are not epistemically justified in using induction (though there is a psychological story that explains our confidence). While self-supporting inductive arguments involve arguing in a circle, any other attempt to justify induction results in infinite regress, i.e., if we use one principle to justify law in science, then this principle stands in need of justification, and so on.

Salmon, Max Black and Urmson defend induction whereas Russell and Popper reject induction. Popper's theory is known as anti-inductivism or non-inductivism. Popper replaces verifiability by falsifiability.

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Check Your Progress III

Note: a) Use the space provided for writing your answer.

b) Check your answers with those provided at the end of the unit.

1. Explain the concepts 'analytic and synthetic' and 'a priori and a posteriori'.

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2. Comment upon the criticisms made against deductive and inductive inferences.

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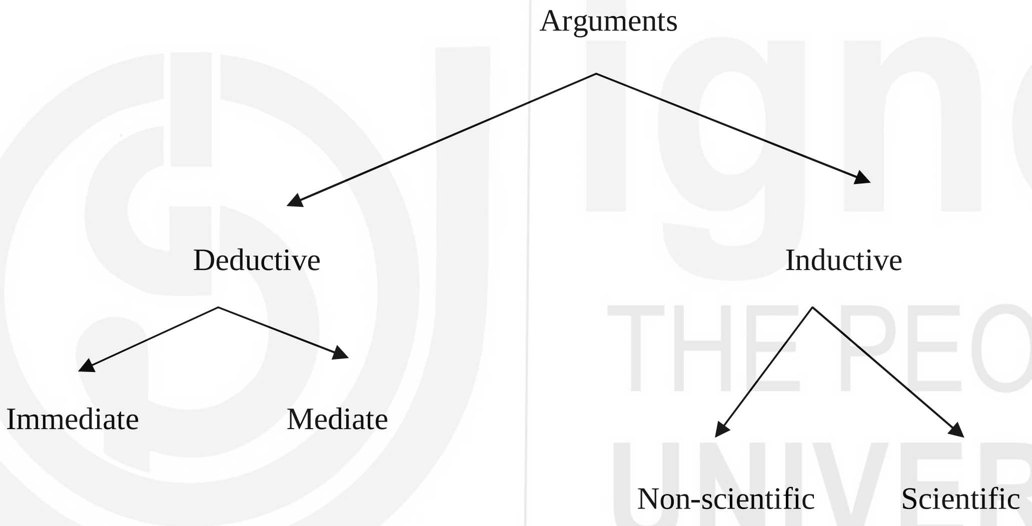
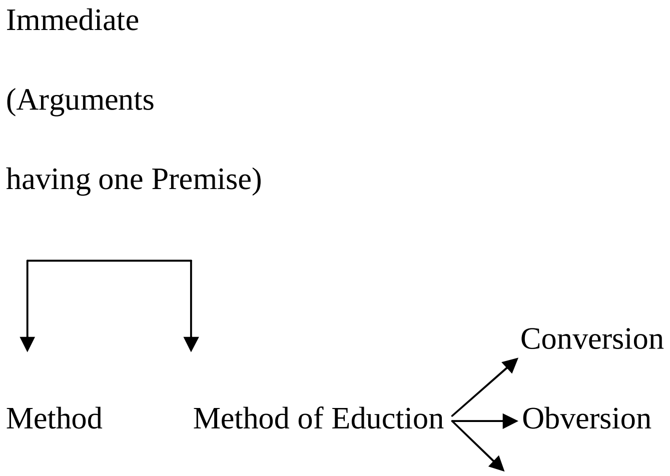
3.6 TYPES OF INDUCTIVE ARGUMENTS

In deductive logic different types of deductive arguments are discussed based on the form of the argument. The form differs based on the number of premises and how terms, premises-conclusion is arranged in relation to each other. In the deductive reasoning conclusion is certain and there is no difference in type of deductive arguments based on conclusion. On the other hand in inductive reasoning the conclusion differs in degree. Inductive reasoning takes specific information and makes a broader generalization, but there are other forms also different from generalization. There are other forms of inductive arguments in which conclusions are drawn by appeal to evidence, or authority, or causal relationships. Different methods used in deductive logic to find validity of arguments are the subject matter of your present logic course. It's been discussed at length in the next two blocks. Here in this section we will take a brief look at type of inductive arguments specifically type of inductive generalizations. Broader sub-categorization of these two types of arguments can be done as follows:



Graph 1: Arguments: deductive and Inductive



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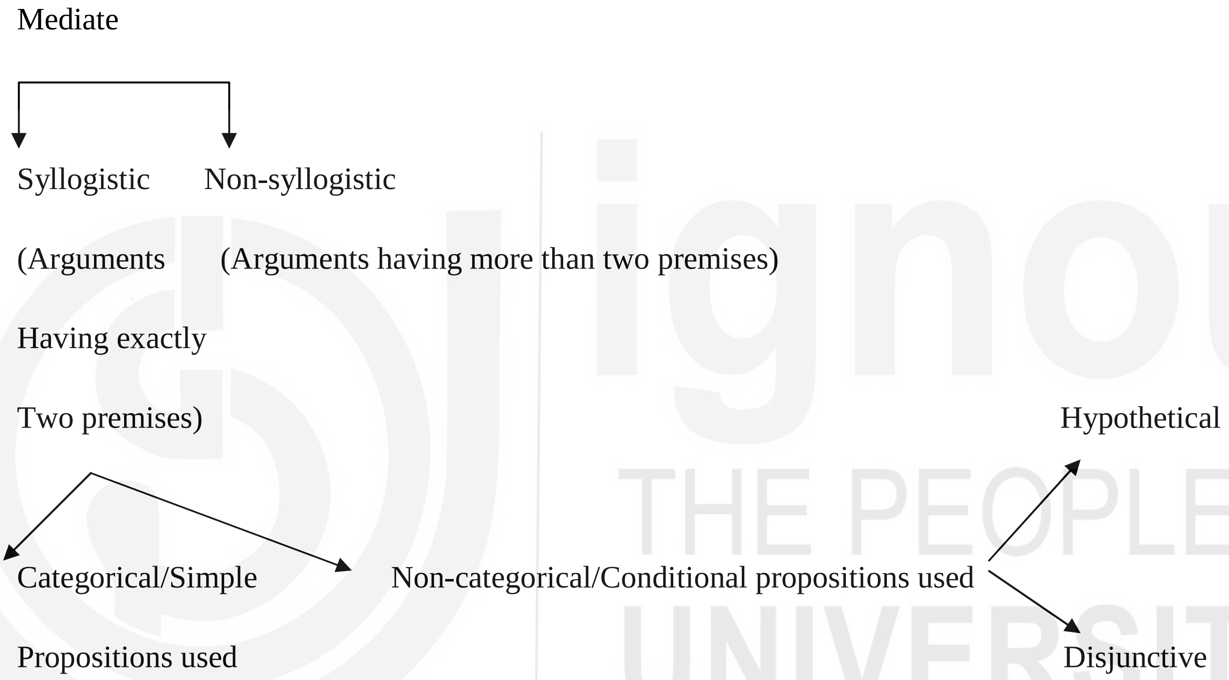
of Square of Contraposition

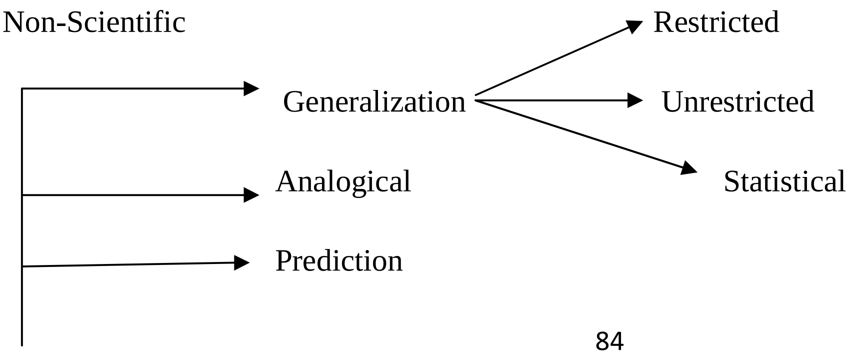
Opposition of Proposition

Graph 2: Immediate Argument



Graph 3: Mediate Argument

(Inductive)



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→ Based on Authority

Graph 4: Non-Scientific

Scientific

↓

Causal (Methods of Finding Causal Relationships: Method of agreement, Method of disagreement, Joint method, Method of residues, Method of concomitant variation)

Graph 5: Scientific

Let us now have a look at types of inductive reasoning:

Generalization: Inductive generalization proceeds from specific sample observations to general ideas about the whole population. In generalization one draws conclusions based on recurring patterns or repeated observations. To generalize, one observes multiple instances and finds common qualities or behaviors and then makes a broad or universal statement about them. There are some fallacies related to this type of generalization known as hasty generalization and biased sample usage. When generalization is done after observation of all the cases then it is known as induction by complete enumeration.

There are three types of generalizations: unrestricted, restricted and statistical.

Generalization is said to be unrestricted when it does not include exceptions in any form. It is restricted when some restrictions are imposed individual, spatial or temporal. Development in certain fields like statistics has given rise to a different type of generalization which may be called statistical generalization. Statistical generalization requires a fair sample within which a study is undertaken yielding a certain ratio. This is, surely, an example of empirical approach. Observations made within this sample are extended to the parent class, i.e. the class of which the sample forms a part. It is quite likely that we may arrive at a certain ratio within a fair sample whereas within the parent class we may arrive at some other ratio if certain other parameters influence the rest of the class. Another type of statistical generalization results when observations made in one sample become the ground to make observations in some other sample. In all such studies, it is frequency of occurrence of an event which matters. It is of

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utmost importance that in any statistical study fair sample should consist of elements selected by the same procedure.

Analogical: Inductive analogy proceeds from known similarities between two things to a conclusion about an additional attribute common to both things. If some attribute A is true for X, Y and Z and later on we find that X and Y have attribute B, we based on analogy infer inductively that it is most likely that Z also possesses attribute B. The fallacy of false analogy is related to this process. Analogy excludes generalization of all types. Still, it is inductive, because with its help we pass from 'observed' to 'unobserved'. This particular inference is, evidently, intuitive and intuition is, essentially, subjective. But in this case the subjective nature of intuition does not pose any problem because what is inferred can be tested by anyone. Hence, analogy can be regarded as objective and also as inference.

Prediction: a conclusion about a future individual from a past sample.

Induction based on authority: An argument from authority draws a conclusion about the truth of a statement based on the proportion of true propositions provided by an authoritative source. It has the same form as a prediction.

Causal: A causal inference draws a conclusion about a causal connection based on the conditions of the occurrence of an effect. Premises about the correlation of two things can indicate a causal relationship between them, but additional factors must be confirmed to establish the exact form of the causal relationship.

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3.8 LET US SUM UP

Reasoning is of two types: inductive and deductive.

Deductive Reasoning:	Inductive Reasoning:
● The relation between premises and conclusion is that of necessity. Premises are sufficient to draw a conclusion beyond any doubt. ● Addition of more statements to premises does not change the	● The relation between premises and conclusion is probable. Premises merely suggest a conclusion but do not entail or imply it. ● Addition or subtraction of information changes the status of conclusion in an

conclusion of a valid deductive argument. ● Deductive reasoning is formal in character. Form decides the status of the argument. ● Deductive argument is evaluated either as valid or invalid. ● Valid arguments may consist of either true statements or false statements. But a significant aspect of valid deductive argument is that a false conclusion cannot be drawn from all true premises. ● Sense experience is irrelevant in deductive logic. Intellect is the key to deductive inference. ● Logical certainty, a priori nature and rationality are the qualities of deduction.	inductive argument. ● In induction content/ matter determines acceptability of inference. ● Inductive arguments are evaluated as strong or weak, acceptable or not acceptable, sound or unsound, appealing or non- appealing. ● There is nothing contradictory in accepting all true premises and a false conclusion in an inductive argument. ● Premises are observational statements based on sense experience. Generality (in conclusion) is the characteristic of induction. ● Inductive inference is probable, uncertain, *a posteriori* and empirical.

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3.9 KEY WORDS

Probability: Probability is a technical term used extensively in all sciences which use quantitative analysis. It is, generally, issued to deal with projection which is future-oriented or past-oriented. It is always expressed in proper fraction where the denominator points to the total number of possibilities and the numerator points to the issue at stake.

Axiom: In traditional logic, an axiom or postulate is a proposition that is not proved or demonstrated but considered to be either self-evident, or subject to necessary decision. Therefore, its truth is taken for granted, and serves as a starting point for deducing and inferring other (theory dependent) truths.

Hypothesis: A hypothesis consists either of a suggested explanation for an observable phenomenon or of a reasoned proposal predicting a possible causal correlation among multiple phenomena.

3.10 FURTHER READINGS AND REFERENCES

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3.11 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress I

1. One of the characteristics of deductive logic is its formal character in virtue of its emphasis upon the structure and form of argument. Only statements are true (or false) whereas only arguments are valid (or invalid). We generally think that combination of true statements will lead to valid arguments and false to invalid, but this is not the case. All true statements may give an invalid argument or all false statements can give valid arguments. Validity or invalidity of the argument depends on the form of the argument. It means that truth and validity may or may not coincide with each other. But, in any valid deductive argument false conclusions cannot be drawn from all true premises. In this case, necessity is of a particular kind, i.e. logical necessity.

Check Your Progress II

1. In inductive reasoning the relation between premises and conclusion is probable. Premises merely suggest a conclusion but do not entail or imply it. Premises of the inductive reasoning are observational statements based on sense experience. Generality (in conclusion) is the characteristic of induction. Probability of inference is a matter of degree which is always in a variable fraction. Inductive arguments are evaluated as strong or weak,

acceptable or not acceptable, sound or unsound, appealing or non- appealing. In induction content/ matter determines acceptability of inference. Addition or subtraction of information changes the status of conclusion. This may make inference more strong or weaken it. There is nothing contradictory in accepting all true premises and a false conclusion in inductive argument. Inductive arguments are uncertain, *a posteriori* and empirical.

Check Your Progress III

1. Analytic sentences are true by definition, and are self-explanatory. Let us take an example: 'All bachelors are unmarried men'. This statement is true in virtue of the meaning/ definition of the word 'bachelors'. In analytic statements the predicate term is contained in its subject term. Knowledge obtained from an analytic statement is necessarily a priori, i.e. knowledge prior to sense experience. Deductive logic provides knowledge a priori, though the premises and conclusion considered separately are not analytic. However, deductive argument and analytic statement share a common characteristic. In both the cases, denial leads to self-contradiction. Any knowledge before experience is a priori and that knowledge which comes after experience is called a posteriori. In synthetic statements the predicate term is not contained in its subject term but related to it. Consider the example 'All creatures with hearts have kidneys.' Here the subject 'creature with heart' does not contain this information that they 'have kidney'. Inductive arguments are considered to be of the nature of synthetic judgments.

2. Induction has attracted more criticism than deduction. The criticism against deduction was made by J.S. Mill with reference to one type of deductive argument known as syllogism. Mill contends that syllogism is guilty of repeating the premises in conclusion. The aim of logic is to achieve progress on knowledge. Deductive logic fails to achieve this particular aim.

   Induction, on the other hand, is open to more serious criticisms. Hume raises objections to one form of induction known as ampliative induction. Generalization is considered a hallmark of inductive reasoning. The objections to generalization are formulated on one ground; no proof in strict mathematical or deductive sense is possible when we deal with induction. Inductive inference can only be vindicated because any attempt to justify the same runs into infinite regress or becomes circular. Generalization can only be disproved or falsified though it cannot be proved.

UNIT 4 TRUTH AND VALIDITY[*]

Structure

4.0 Objectives
4.1 Introduction
4.2 Truth and Logic
4.3 Validity and Logic
4.4 Assessment of Deductive Logic
4.5 Sound and Unsound Deductive Arguments
4.6 Significance of Validity in Deductive Logic
4.7 Assessment of Inductive Logic
4.8 Comparison of Deductive and Inductive Arguments
4.9A Brief Note on Indian Logic
4.10 Let us Sum Up
4.11 Key Words
4.12 Further Readings and References
4.13 Answers to Check Your Progress

4.0. OBJECTIVES

The objective of this unit is to introduce you to the concepts of Truth and Validity in Logic. Understanding the concepts like Truth and Validity and their relationship plays a crucial role in evaluating arguments, i.e., in distinguishing good from bad arguments. Through the analysis of different aspects of Truth and Validity in Logic we can learn:

- the meaning and importance of truth in Logic

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- the meaning and importance validity in Logic
- the relationship between truth and validity in Deductive Logic
- the application of similar concepts in Inductive Logic
- the application of similar concepts in Indian Logic

4.1 INTRODUCTION

The fundamental aim of Logic is to provide an apparatus for distinguishing between good and bad argument. In the preceding units we have learnt about the nature of Logic and the nature of Deductive and Inductive Logic. In this unit you shall learn the terminologies and concepts that are used in formal logic to evaluate arguments and to distinguish between good and bad arguments. Two such concepts are “Truth” and “Validity” and their inter-relationship. The evaluation of an argument can be carried out through an exploration of following questions: (a) Are all the premises of an argument true? (b) Do the premise/premises support the conclusion? This second question is specifically more pertinent because an answer to this can help us determine the value of an argument. Additionally, we also need to determine the manner and the extent to which the truth or falsity of the premises effects the evaluation and the value of argument. In the course of the present unit, we shall learn the concepts and terminology used in this respect and explore these issues as they appear across deductive and inductive arguments.

4.2 TRUTH AND LOGIC

Let us first understand the concept of truth and its relevance in Logic. Truth is an attribute of a proposition and it refers to what is really the case. A proposition is an assertive sentence that can be either true or false. So “truth” and “falsity” are truth values of a proposition. A proposition can be a premise of an argument and it could be true. Also a proposition could be a conclusion of an argument and it could be false. Take the following argument:

All men are immortal. (Premise 1)

Hari is a man. (Premise 2)

Therefore, Hari is immortal. (Conclusion)

Here premise 1 is false, premise 2 is true, and the conclusion is false. The truth value of the above propositions is known to us. But logic is not concerned about whether these propositions are actually true or not. Logic tries to determine, in a case where the given premises are true, if we can necessarily draw the conclusion from the premises. This leads to the issue of validity.

4.3 VALIDITY AND LOGIC

Validity is a fundamental concept of Logic. According to logician I. M. Copi, “Validity is a formal characteristic; it applies only to arguments, as distinguished from truth, which applies to [individual] proposition[s]”. Validity is an attribute of an argument. An argument is valid if the relationship between its components are so that the premises conclusively prove the conclusion. That means, validity is about the logical connection between the propositions. Take the following example:

All men are saints.

Einstein is a man.

Therefore, Einstein is a saint.

The conclusion of this argument necessarily follows from the premises. In the above argument, if the premises were true, then there is no possible scenario where the conclusion would be false. Therefore, this argument is a valid one. Conversely, if the conclusion is not a logical necessity, then the argument is not valid, and it will be called an invalid argument. Now one can raise a question here concerning whether the validity of the argument is decided by the truth value of the proposition; more precisely one may ask- what is the exact connection between truth and validity in the context of an argument? We shall discuss that in a while. Before that we need to understand two things clearly.

First, in ordinary language ‘validity’ can be used interchangeably with ‘truth’ and vice versa, but in Logic, the concept of validity applies only to arguments, and the concept of truth applies exclusively to propositions.

Second, the definition of validity as a “logical necessity” confines the concepts of validity and invalidity to Deductive Logic only. Because, according to I. M. Copi, deductive arguments make the claim that its premises conclusively support the conclusion, while in case of Induction, the premises do not conclusively support the conclusion.

Keeping in view this clarification, in the next section we shall explore in greater detail the concept of validity and its relationship with truth in Deductive Argument.

Check Your Progress I

Note: (a) Use the space provided for your answer

(b) Check your answers with those provided at the end of the unit.

1. In general what makes an argument valid?

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2. Is validity dependent on the actual truth of propositions?

4.4 ASSESMENT OF DEDUCTIVE LOGIC

It is clear that validity as a logical concept is exclusively applied on deductive arguments only and therefore it is an important part of any discussion on Deductive Logic. Validity can be properly defined in the context of deductive arguments. The objective of deductive arguments is to establish that the conclusion undeniably follows from the premises. When it achieves this objective, the argument is said to be valid, and when it fails to achieve this objective then the argument is not valid and therefore it can be termed as being an “invalid” argument.

But how do we know that a deductive argument has achieved its objective? How do we ascertain whether the argument is valid? In reply to this query, it may be noted that if the premises are true in a deductive argument, and there is no logical possibility of the conclusion being false, then it is a valid. Let us consider an example:

All Fast foods are unhealthy.

French Fry is a Fast Food.

Therefore, French Fry is Unhealthy.

We know that if the premises in this argument are true then the conclusion can never be false. Therefore, this is a valid argument. The validity is determined by the relationship between the premises and the conclusion. If the object "French Fry" is included in the group of "Fast Food" (second premise) and if "Fast food" is included in the group of "unhealthy" things (first premise), then the object "French Fry" is necessarily included in the group of "unhealthy" things(conclusion). You can see that the above relationship gives a particular form of the argument and this form is a valid one. Because, in this form, if we assume that the premises are true, then the conclusion will be necessarily true, and to claim it as false will be contradictory. Interestingly if we use an argument with utterly false propositions, yet fulfilling the same argument "form" like the one given above, it will still be valid.

All mammals have wings.

All plants are mammals.

Therefore, all plants have wings.

All the propositions in the above argument are false, but the argument is still valid, because the logical relationship of the propositions is such that if the premises were actually true, the conclusion would be certainly true.

The two sets of examples discussed above, however raise a serious question with regard to the nature of the relationship between truth and validity in deductive arguments. It may be asked whether there is any connection between the truth value of the proposition and validity/ invalidity of the argument? Deductively Logic largely engages in answering these questions and formulating rules and principles for determining validity. In this Unit, however, we shall develop an outline of the critical and complicated relationship of truth and validity.

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As we have seen earlier, the relationship between argument and propositions is a structural one. The validity and invalidity of an argument depends on the logical relationship between its propositions. Propositions are constituent parts of an argument. Every argument can have one proposition as conclusion and at least two or more propositions as premises. Each proposition can be true or false, and every argument must be either valid or invalid. Logicians have noted that there are several arrangements of truth/falsity and validity/invalidity. These arrangements will provide crucial clues to understand the relationship between truth and validity in Deductive Logic. Let us explore those arrangements with examples.

Arrangement 1: *True Premises, True Conclusion, Valid Argument*

Example: All mammals are animals.

All cats are mammals.

Therefore, all cats are animals.

In this argument, all the propositions are known to be true. The premises conclusively establish the conclusion; therefore, making the argument "valid".

Arrangement 2*: False Premises, False Conclusion, Valid Argument*

Example: All mammals are six legged animals.

All Ostriches are mammals.

Therefore, all Ostriches are six legged animals.

In this argument, all the propositions are known to be false. But here the premises conclusively establish the conclusion, because if the premises were actually true, the conclusion would have been certainly true. Therefore, this argument is also valid.

Arrangement 3: *True Premises, True Conclusion, Invalid Argument*

Example: If I won the KBC Show, I would be a millionaire.

I did not win the KBC show.

Therefore, I am not a millionaire.

The premises and conclusion here are true, the argument is invalid because the conclusion does not necessarily follow from the premises. This will be further clear from the next example.

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Arrangement 4: *True Premises, False Conclusion, Invalid Argument*

Example: If Ratan Tata won the KBC Show, he would be a millionaire.

Ratan Tata doesn't win the KBC show.

Therefore, Ratan Tata is not a millionaire.

In this argument the premises are true, but the conclusion is false in reality. Mr. Tata till now didn't participate in KBC show, but he is one of the richest persons in India.The argument is invalid because the premises don't conclusively establish the conclusion.

Arrangement 5: *False Premises, True Conclusion, Valid Argument*

Example: All Fishes are mammals.

All dolphins are fishes.

Therefore, all dolphins are mammals.

The conclusion here is true in reality, but the premises are unquestionably false. However, since there is a logically necessary connection between the premises and the conclusion, because of which the premises conclusively support the conclusion, the argument is valid.

Arrangement 6: *False Premises, True Conclusion, Invalid Argument*

Example: All mammals have wings.

All dolphins have wings.

Therefore, all dolphins are mammals.

This argument has two false premises and still the conclusion is true. However, the argument is invalid, because the conclusion is not conclusively supported by the premises. We know that by examining the form of the argument. Here, in the second premise the group "all dolphins" belongs to the group "wings", and in first premise, the group "all mammals" belong to the group "wings", and these don't prove whether the group "all dolphins" belong to the group "mammals"

Arrangement 7: *False Premises, False Conclusion, Invalid Argument*

Example: All mammals have wings.

All dolphins have wings.

Therefore, all mammals are dolphins.

In this argument both premises and conclusion are false. And the argument is invalid. Because the conclusion is not supported by the premises. Like Arrangement 6 above, here also in the second premise the group "all dolphins" belongs to the group "wings", and in first premise, the group "all mammals" belong to the group "wings", and these don't prove whether the group "all mammals" belong to the group dolphins" (in most of the above examples we have used particular form of Deductive Argument known as Categorical Syllogism. We shall learn more about this type and the methods of checking the validity of such arguments in Block: 3 Categorical Syllogism)

Arrangement 8: *True Premises, False Conclusion, Valid Argument*

Example: Nil

By definition, in a deductively valid argument if the premises are true, it is impossible for the conclusion to be false. If the conclusion is false, when premises are true, that means the conclusion is not conclusively supported by the premises. Therefore, the argument will be always invalid. That is why there is no example of **Arrangement 8**.

The above discussion on the eight possible arrangements (of which the 8th arrangement is, in fact, impossible) of true and false propositions and valid and invalid arguments reveals that firstly, truth or falsity of the conclusion of an argument cannot determine on its own the validity or invalidity of an argument, and, secondly, validity of an argument does not guarantee the truth of its conclusion. Valid argument can have all false propositions and invalid argument can have all true propositions. Sometimes, false premises can lead to true conclusion in valid as well as invalid arguments.

This complex and critical relationship can further be exposed in the following table.

Premise	**Conclusion**	**Validity**
True	**True**	**Valid/Invalid**
True	**False**	**Invalid**
False	**True**	**Valid/Invalid**

False	**False**	**Valid/Invalid**

This table shows that the validity or invalidity of an argument cannot be determined merely from the truth and falsity of the propositions. Both valid and invalid arguments can have all true propositions or all false propositions, or they can have false premises and a true conclusion. As we have seen there are seven possible combinations of truth/falsity and validity/invalidity. The combination that is impossible is a combination of valid argument with all true premises and a false conclusion. To put it differently, we can say that if there is a false conclusion in a valid argument, then at least one of its premises must be always false. Thus there is one instance where truth and falsity is a determining factor for validity/invalidity. Any deductive argument having actual true premises and actual false conclusion is always invalid. Because, if the premises are actually true, and the conclusion actually false, then it is *possible* that that the premises can be true and conclusion can be false. But we already know that in a valid deductive argument if the premises are true, then it is *impossible* for the conclusion to be false.

4.5 SOUND AND UNSOUND DEDUCTIVE ARGUMENTS

The evaluation of deductive argument is not limited to identifying valid and invalid arguments. Depending on its relationship with truth, arguments can be further classified as “sound” and “unsound”. A sound argument is a deductive argument that is valid and it has true premise. It must satisfy two conditions: the argument must be valid, and the premises must be true. If any of this condition is not met, then no valid argument can be termed as sound. Consider the following argument:

All planets of the solar system revolve around the Sun.

The Earth is a planet of the Solar System.

Therefore, the Earth revolves around the Sun.

This argument is valid because the logical relation between the propositions are so that if the premises were true, then the conclusion would be certainly true. This argument is valid and in addition, the premises here are actually true. So this is a Sound deductive arguments. Now one can ask whether the conclusion in such a case will also be true? The answer is always yes.

Because, by definition of validity, if the argument is valid and if its premises are true, then it is impossible for the conclusion to be false. We already know that in a sound argument the argument is valid and the premises are actually true, therefore, now we can say that the conclusion will be actually true.

In contrast to Sound argument, unsound arguments are those which do not satisfy the conditions of a sound argument. To put it clearly:

1. An argument which is invalid is unsound.
2. An argument which is valid but has false premises is unsound.

Following these conditions, if we consider the eight arrangements of truth and validity described in section 4.4 we shall find that only **Arrangement No.1** is sound. All other possible combinations of truth/falsity and validity/invalidity are always unsound. Thus **Arrangement no.1** is an instance of a sound deductive argument which is valid and has actual true premises, and therefore, by definition, always gives an actually true conclusion. A sound argument can also be termed as a good deductive argument in the fullest sense of the term. All deductive arguments are either sound or unsound.

4.6 SIGNIFICANCE OF VALIDITY IN DEDUCTIVE LOGIC

It is obvious from our discussions so far that logicians are interested in the evaluations of arguments, rather than in the evaluation of propositions. The evaluation of deductive arguments is measured in terms of validity and invalidity. Valid and invalid arguments are further evaluated as sound and unsound arguments. Sound arguments are what can be termed as good arguments, that can lead us to actually true conclusions with utmost certainty. In such a situation, one can ask, why logicians do not confine themselves to the study of arguments with true premises only as that may lead us to sound arguments? What is the importance of the non-sound valid arguments? Specially, what is the importance of exploring valid arguments whose premises are not true?

Actually the validity of arguments with premises not known to be true are more important than they seem to be. In our day-to-day life, we often need to choose between alternative courses of action where we do not know which alternative is in fact true. What we do is consider consequences of these alternative courses. On considering the consequences, we decide which course of action should be followed.We need to be serious in deciding the consequences of the alternative courses. That is where our training in valid argument with false premises can help us. Because, in case of valid argument with false premise, the logical relation between premises and conclusion is such that if the premises were true, the conclusion would be also true. If we follow a similar valid logical process in deciding the consequences, then we can correctly choose the alternative course of action. Thus here we “make’ (as I. M. Copi puts it) the premises true out of the available alternative courses. But if we deal with only already known true premises, then there will be no point in considering alternative courses, we can accept the one which is true. The purpose of applying logic here will be self-defeating. But the reality is that there will be always alternative courses in life where truth of the alternatives may not be known us.

Another important aspect is the use of deductive logic in the Sciences. Scientists often verify scientific theories using deductive method. Many theoretical premises cannot be verified as true. But scientist can deduce particular testable instances from such theories. Such particular instances can be tested for truth, which further confirms the theory in question. But this will only work, if the process of such a deduction follows a valid path.

Check Your Progress II

Note: (a) Use the space provided for your answer.

(b) Check your answers with those provided at the end of the unit.

1. Give an example of a valid argument with all false propositions

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2. Give an example of an invalid argument with all true propositions

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3. What is the difference between valid and sound argument?

4.7 ASSESMENT OF INDUCTIVE LOGIC

Our understanding of Truth and Validity in Deductive Logic can be further enhanced by considering the case of Inductive Logic. Every deductive argument claims that its conclusion necessarily follows from the premises, that means that if the premises are true then it is *impossible* for the conclusion to be false. The task of a logician is to verify these claims. If the claim is correct the argument is valid, if the claim is incorrect, the argument is invalid. There is no middle ground between valid and invalid. In contrast, an inductive argument claims that the conclusion *probably* follows from the premises, i.e., to say if the premises are true, then it is improbable for the conclusion to be false. Logicians examine these claims of probability. But probability is a matter of degree. There is no certainty of the conclusion being true, even if the premises are true, even if the procedure of induction is correctly followed. Therefore, the terms “validity” and “invalidity” are not applicable here. In fact, there is no term fixed by logicians to identify good and bad inductive arguments. However, the terms “Strong” and “Weak” are used by some logicians for the evaluation of inductive arguments.

An inductive argument is strong when it achieves its objectives. The objective of an inductive argument is to establish that it is improbable for the conclusion to be false when the premises are true. The conclusion here has a probability of being supported by the premises. On the other hand, a weak inductive argument is the one which fails its objective. So in a weak inductive argument, the conclusion does not probably follow from the premises, even though it is claimed so.

Now let us focus on the evaluation of inductive arguments through an examination of the relationship between truth/falsity and strength/weakness of inductive arguments. The testing of the strength of inductive arguments is comparable to testing of the validity of deductive arguments. In inductive arguments also, we assume that the given premises are true, and on the basis of this assumption we try to determine whether the conclusion is probable. Like deductive arguments, here also we need to establish the connection between premises and conclusion. But unlike deductive arguments, in inductive arguments we cannot just focus on the form of the argument. The conclusion of an inductive argument could be a generalization, an analogy, a prediction, etc. There is always a "leap" from certain to uncertain, from particular to general, because the conclusion tends to contain more information than the premises. This "inductive leap" is possible because of two principles, that are also known as the formal grounds of induction. The first principle is the Law of Uniformity of Nature and the second principle is the Law of Causation. According to the law of uniformity of nature there is uniformity in nature, i.e., under similar conditions nature behaves in a similar manner, that is to say that the future repeats the past. The Law of Causality states that every event has a cause, so if X is the cause of Y, whenever there is X, it will always be followed by Y. On the basis of these principles, if we proceed from particular premises to a general conclusion in Induction, the argument will be strong and the probability of the conclusion being true would be very high.

Now instead of considering the varieties of inductive arguments and the different methods of justification of induction, let us consider how the truth and falsity of propositions of inductive arguments are related to their strength and weakness. Here also we can find several arrangements parallel to arrangement that we examined in case of deductive argument.

Arrangement 1: *True Premises, Probably True Conclusion, Strong Argument*

Example: Every year in last decade there were always heavy rainfall during monsoon in Assam.

Therefore, probably there will be heavy rainfall in the monsoon of this year in Assam.

In this argument the premise is actually true, as there was heavy rainfall every year in last decade during monsoon in Assam. The uniformity of nature dictates that in the next monsoon also there will be heavy rainfall in Assam. This is also what we naturally expect to happen. Thus the conclusion is probably true, and the argument is strong.

Arrangement 2: *True Premises, Probably True Conclusion, Weak Argument*

Example: In 1917, 1996 and 2019, there were heavy rain fall during monsoon in Rajasthan.

Therefore, probably there will be heavy rainfall during next monsoon in Rajasthan.

In this argument, the premise is actually true, the conclusion is probably true. Here we can't apply the law of uniformity of nature as we have supporting information about only three years in a range of more than 100 years. The argument, thus, is a weak one.

Arrangement 3: *False Premises, Probably True Conclusion, Strong Argument*

Example: Every Indian Prime Ministers was a poet.

Therefore, it is probable that the next Indian prime minister will also be a poet.

Here the premise is actually false (some of our prime ministers were good poets, but not everyone was a poet). But if we assume that the premise is true, then we would naturally expect that the prime minister will be a poet. So, the argument is strong.

Arrangement 4: *False Premises, Probably True Conclusion, Weak Argument*

Example: Some Indian Prime Ministers were logicians.

Therefore, it is probable that the next Indian prime minister will be a poet.

Here the conclusion is probably true, but the premise is clearly false and even if we assume the premise as true, we cannot find any link between it and the conclusion. Therefore, the argument is weak.

Arrangement 5: *False Premises, Probably False Conclusion, Strong Argument*

Example: Every Rhino discovered in Assam are two-horned.

Therefore, probably the next Rhino discovered in Assam will be two-horned.

In this argument the premise is clearly false, the conclusion has a high probability of being false. But if we assume the premise as true, then we naturally expect that the conclusion would have been also true. Therefore, the argument is strong.

Arrangement 6: *False Premises, Probably False Conclusion, Weak Argument*

Example: Few Rhinos discovered in Assam are two-horned.

Therefore, probably the next Rhino discovered in Assam will be two-horned.

In this argument, like the previous one, the premise is clearly false, the conclusion has a high probability of being false. But even if we assume the premise as true, the premise does not strongly support the conclusion as the considered instances are very few, so there is very low probability of the conclusion being true, in other words, it has a probability of being false. Therefore, the argument is weak.

Arrangement 7: *True Premises, Probably False Conclusion, Weak Argument*

Example: A few Indian Space Missions have failed.

Therefore, probably the next Indian Space Mission will fail.

Here the premise is actually true. But the conclusion has a high degree of being false because relevant instances are very low leading to very low degree of probability. Therefore, the argument is weak.

Arrangement 8: True Premises, Probably False Conclusion, Strong Argument

Example: Nil

If an inductive argument is strong, and if its premises are true, then the probability of the conclusion being true will be high. Therefore, Arrangement 8 is not possible.

The discussions on these possible arrangements make it clear that the relationship between truth/falsity and strong/weak inductive argument is a complex one. In most of the cases, truth of the premise or strength of the argument do not correlate. That is because the strength of argument is not dependent on the actual truth of the premises, but on the probabilistic support given by the premises to the conclusion. All that the arrangement of truth and falsity establishes is that if the premises are true and conclusion is probably false, then the inductive argument is weak. In other words, if the argument is strong and the premises true, the conclusion is probably true.

As logician Patrick J. Hurley emphasizes, we need to note two important points here. First, in case of true premise in inductive argument, the term “true” shall be taken in its fullest sense. The true premise, thus, should not miss or undermine any crucial information, so that no scope is left for a different conclusion than the intended one. Secondly, in induction when we claim a conclusion as probably false, it means probably false in the actual world in the context of actually known evidence.

Now let us summarize the relationship between strength of Inductive argument and truth and falsity of premises and conclusion.

Premise	**Conclusion**	**Strength**
True	**Probably True**	**Strong/Weak**
True	**Probably False**	**Weak**
False	**ProbablyTrue**	**Strong/Weak**
False	**ProbablyFalse**	**Strong/Weak**

This table makes it clear that merely from the truth and falsity of propositions the strength of argument cannot be ascertained. But when the premises are true and the conclusion probably false, then the argument is weak. Because if the premise is true in the sense explained above, and the argument is strong, then conclusion would be probably true instead of being probably false.

The above table can be drawn parallel to the table drawn for deductive argument. However, there is one major difference. In case of deductive argument, the truth of conclusion is absolute, i.e., it can be either true or false. But in case of induction the truth of conclusion is a matter of degree. In a strong argument it has a probability of being true, in weak argument, it has higher probability of being false. The degree of probability depends on how the premises are supporting the conclusion.

Thus if we consider Enumerative Induction which relies on simple enumeration of available instances we can see how the degree of probability shifts depending on considered instances.

Example 1. The 5 mangos checked randomly from the bag of 100 mangos are ripe.

Therefore, probably all 100 mangos in the bag are ripe.

Example 2. The 80 mangos checked randomly from the bag of 100 mangos are ripe.

Therefore, probably all 100 mangos in the bag are ripe.

The first example is a weak argument and the second is a strong argument. But they are not absolutely strong or weak. Adding additional instances in first case may increase its probability, removing instances from the second will decrease its probability. Also, addition of new information can also affect the strength of inductive argument. For example, if we add the premises “3 mangos were checked and found to be unripe and removed from the bag” will make both the arguments weaker.Thus, for inductive argument to be strong, the premises must provide probabilistic support to the conclusion.

The categorization of strong and weak inductive argument helps a logician’s endeavor to distinguish between good and bad arguments. But the process is not limited to this division only. Some logicians further divide inductive arguments into Cogent and Uncogent Inductive Arguments. A Cogent argument is an inductive argument which is strong and has true premises. Here truth of premises means complete truth as defined earlier. Any argument which fails to meet these criteria is Uncogent. Thus weak arguments and even strong arguments with false premises or false conclusion is Uncogent. But it may be noted that it may not be possible to always meet these conditions of Cogent arguments in real life situations. Therefore, the study of strong and weak arguments is more relevant for real life, especially in sciences, than limiting it to just cogent arguments.

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4.8 COMPARISON OF DEDUCTIVE AND INDUCTIVE ARGUMENTS

We can compare the conceptual difference between the evaluation of induction and deduction as follows. Here we shall compare the status of the conclusion in each type of arguments assuming the premises are true;

	DEDUCTIVE ARGUMENT		**INDUCTIVE ARGUMENT**	
STATUS OF ARGUMENT →	**VALID**	**INVALID**	**STRONG**	**WEAK**

STATUS OF THE CONCLUSION →	**IMPOSSIBLE TO BE FALSE**	**POSSIBLE TO BE FALSE**	**IMPROBABLE TO BE FALSE**	**PROBABLE TO BE FALSE**

The above table clearly shows the conceptual difference between deduction and induction in regard to their assessments. While in valid deductive argument if the premises are true, there is absolute certainty of the conclusion being true, on the other hand, even if the premises are true, in case of even a strong inductive argument, there is no such certainty, but only high degree of probability. The table also helps us to realize how truth or falsity of premises are related to good and bad deductive and inductive arguments.

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Check Your Progress III

Note: (a) Use the space provided for your answer.

(b) Check your answers with those provided at the end of the unit.

1. In respect of truth, what is the difference between a valid deductive argument and a strong inductive argument?

----

2. In a inductive argument with true premise what is the condition of “truth”?

4.9 A BRIEF NOTE ON INDIAN LOGIC

There are several approaches to logic in Indian Philosophy from its different schools. But none can be drawn as an exact parallel to either western deductive or inductive logic. In this account it will not be possible to give a detailed account of Indian Logic. We shall instead consider the Syllogism of the *Nyāya* School which is often compared with Aristotelian Categorical Syllogism, which we have largely dealt with in our discussion of Deductive Arguments. A *Nyāya* Syllogism, unlike Categorical Syllogism, has five terms. The arguments consist of typically 5 propositions. Let us begin with an example:

1. This hill has fire. (*pratijñā*)
2. Because it has smoke. (*hetu*)
3. Whatever has smoke has fire, e.g., an earthen oven. (*udāharaṇa*)
4. The hill has smoke, which is invariably associated with fire. (*upanaya*)
5. Therefore, this hill has fire. (*nigamana*)

In this argument, the first is the logical statement that needs to be proved, the second states the reason for the establishment of the statement, the third is universal concomitance along with example, the fourth is the application of the universal concomitance in the present case, and the fifth is the conclusion drawn from the preceding propositions. In this argument smoke is equivalent to middle term of Aristotelian Syllogism. In *Nyāya* Syllogism validity of arguments depends on the middle term, how it connects the major and minor term (here, fire and hill respectively). However, in order for the middle term to actually become a valid reason it needs to satisfy several conditions. When it fails to do so, it leads to fallacies. However, it may be noted that such fallacies are material fallacies and not formal fallacies. Also, when we talk about validity it is not confined to formal validity only like deductive argument.

The interesting fact is that in Indian Philosophy, inference is largely seen as integral part of epistemology. Inference is a means to arrive at true knowledge. Therefore, Indian Logicians are not particularly concerned about formal soundness and validity or the distinction between the two. Another important point is that, Indian Logic is both deductive and inductive in nature. That is why the assessment criteria that are applied in the case of deductive arguments and inductive arguments in the previous sections are not properly applicable in case of Indian Logic.

4.10 LET US SUM UP

In this unit we have learnt about the concepts that are used to distinguish between good and bad arguments and how the value of arguments is related to the value of propositions.

Truth is a value of propositions and as such the premises of an argument can be either true or false.

We have learnt that in Logic the term validity exclusively applies to deductive argument only, an argument can be valid only when the relationship between premises and conclusion is such that the premises conclusively establishes the conclusion. Such relation can exist only in deductive argument. When a deductive argument fails to provide conclusive support to its conclusion, it is known as invalid deductive argument. So validity is purely a formal quality of an argument.

The validity or invalidity of argument is not effected by the actual truth of the proposition. We can find varying arrangement of true and false propositions in both valid and invalid arguments. However, the definition of validity is such that if the premises are actually true, then the conclusion cannot be false. Thus when there is a valid argument with actual true premises, it is termed as a sound argument. But we have also learnt focusing only on sound deductive argument does not serve the purpose of logic.

In case of Inductive arguments, we have learnt that the term “strong” and “weak” are used for evaluation of the correctness of the argument instead of “valid” and “invalid”. Because in inductive arguments the relationship between the premises and conclusion are such that the premises only provide probabilistic support to the conclusion. Thus in a strong argument if the premise are true, then it is improbable for the conclusion to be false. Probability is a matter of degree which depends on the level of support provided by the premise. When the probability of the conclusion being true is low, the argument is weak. A strong inductive argument with actual true premises is called a cogent argument.

Finally, we have also learnt that the complex relationship between truth and validity is not exactly applicable in case of Indian logic because Indian logic which is a complex mixture of deductive-inductive procedure.

4.11 KEY WORDS

Cogency: Cogency is a criterion used to further categorize Strong and Weak arguments. A strong argument with true premises is known as a cogent inductive argument. Strong arguments with false premise/premise and all weak inductive arguments are Uncogent arguments.

Soundness: Soundness is another criterion for categorizing deductive arguments. A sound argument is a deductive argument that is valid and all its premises are true. Valid arguments with false premise/premises and all invalid arguments are unsound.

Strength: The term strength is applied by some logicians to evaluate inductive argument as the term validity cannot be applied here. Depending on the probabilistic support provided by the premises to the conclusion an argument could strong or weak. Induction relies on the probability of the conclusion and probability is a matter of degree. An inductive argument is strong when it establishes that it is improbable for the conclusion to be false when the premises are true. When the premises fail to provide such support the argument is weak.

Truth: Truth is an attribute of a proposition and it refers to what is really the case. A proposition is an assertive sentence that can be either true or false. So “truth” and “falsity” are truth values of a proposition.

Validity: The term “validity” is applied to deductive argument only. An argument can be valid or invalid. An argument is valid if the relationship between its components is so that the premises conclusively prove the conclusion. When premises cannot support the conclusion conclusively, the argument is invalid. So, validity is about the logical connection between the propositions.

4.12 FURTHER READINGS AND REFERENCES

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4.13 ANSWERS TO CHECK YOUR PROGRESS

Answers to Check Your Progress I

1. An argument is valid if the relationship between its components are so that the premises conclusively prove the conclusion. So, validity is dependent on the logical connection between the propositions

2. Validity is not dependent on actual truth of propositions. In a valid argument the propositions are related in such a manner that if the premises are true, the conclusion cannot be false.

Answers to Check Your Progress II

1. Example of Valid argument with all false propositions

All birds are four-winged animals.

All cows are birds.

Therefore, all cows are four-winged animals.

2. Example of an invalid argument with all true propositions

Some men are adventurous.

Some men are writers.

Therefore, some writers are adventurous.

3. Sound argument is a type of valid argument in which the premises are true. By definition the conclusion of a sound argument is also true. One can thus say that sound argument is a valid argument with all true propositions. There are many valid arguments where premises and conclusion are false. Therefore, we can say that all sound arguments are valid arguments, but all valid arguments are not sound arguments.

Answers to Check Your Progress III

1. In valid deductive argument, if the premises are true, it is impossible for the conclusion to be false. In contrast, in a strong inductive argument, if the premises are true, then it is improbable for the conclusion to be false. Thus the truth of the premises in valid deductive argument gives absolute certainty of a true conclusion, but in case of strong inductive argument, the truth of premises proves only a probabilistic support to a true conclusion.

2. In case of inductive argument with true premises, the term “true” shall be taken in its fullest sense. The true premise, thus, should not miss or undermine any crucial information, so that no scope is left for a different conclusion than the intended one. Thus helps in reaching a high degree of probability a true conclusion.

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BPYC-133

Block 2

TRADITIONAL LOGIC

Block 2 “Traditional Logic” comprised of six units, tries to present the various aspects of traditional logic; categorical proposition, quality, the quantity of a proposition, and distribution of terms, informal fallacies, square of opposition, existential import. This block also discusses the methods to translate ordinary language statements into standard-form categorical propositions. These discussions will enable learners to understand the difference and relation between traditional and modern development of logic and the relation between our day to day language and logical language and also why there is a shift from ordinary language to ideal language and the need and significance of special kind of language into the realm of logic.

Unit 5 “Categorical Proposition” aims to understand the nature of categorical propositions; the fundamental unit of a categorical syllogism. In this unit, the learner will find the discussion on the difference between sentence and proposition, categorical propositions and the types of propositions in classical and modern logic, four kinds of categorical propositions and the structure of standard form categorical proposition.

Unit 6 "Quality, Quantity, and Distribution" aims to develop a clear understanding of the structure of a standard form categorical proposition. This unit discusses two essential attributes of a categorical proposition: Quality and Quantity; the meaning of 'term' and its various kinds; 'distribution of terms' depending on the quality and quantity in a standard form categorical proposition.

Unit 7 "Translating Categorical Proposition into Standard Form" aims to present the methods to translate ordinary Language statements into standard-form categorical proposition. This unit discusses, arranging standards from ingredients in order; translating terms without nouns by replacing them with plural nouns or pronouns; non-standard verbs to be replaced with standard copula; translating Singular Propositions; translating Categorical propositions whose Quantities are indicated by words other than the standard form quantifiers "All" "No" and "Some"; translating Categorical Propositions which carry words which designate quantity more specifically than standard from propositions; translating Categorical Propositions which do not carry any words at all to indicate quantity; translating propositions which do not resemble standard form Categorical Propositions but can be translated into them; translating Exceptive Propositions; translating Exclusive Propositions; translating Adverbs and Pronouns; translating Conditional Statements.

Unit 8 "Square of Opposition and Existential Import" aims to understand the relations of opposition between the four standard-form categorical propositions by the medium of traditional square of opposition as given by Aristotle. This unit tries to present four relations as presented by Aristotle; namely, Contradictories, Contraries, Subcontraries and Subalternation. The unit also discusses the contribution made by George Boole to resolve the inconsistencies that arose in the traditional square of opposition after the introduction of the concept of existential import.

Unit 9 "Immediate Inference" discusses the immediate inference; Conversion, Obversion and Contraposition. This unit tries to elaborate to study immediate inferences of Conversion, Obversion and Contraposition for all the four standard form categorical propositions.

Unit 10 “Introduction to Fallacies” introduces the logical fallacies emerged in argumentation. The main focus is on informal fallacies, emerged in informal logic. The unit discusses the four main kinds of informal fallacies; Fallacies of Ambiguity, Fallacies of Relevance, Fallacies of Defective Induction and Fallacies of Presumption, and their sub-categories.

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UNIT 5 CATEGORICAL PROPOSITIONS[*]

Structure

5.0 Objectives
5.1 Introduction
5.2 Proposition
5.3 Concept of Proposition in Classical Logic
5.4 Concept of Proposition in Modern Logic
5.5 Categorical Proposition
5.6 The four kinds of Standard form Categorical Propositions
5.7 Venn Diagrammatical Representation
5.8 General Schema of Standard form Categorical Proposition
5.9 Let Us Sum Up

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5.10 Key Words
5.11 Further Readings and References
5.12 Answers to check your Progress

5.0 OBJECTIVES

This unit has the objective of understanding the nature of categorical propositions; the fundamental unit of a categorical syllogism. At the end of the unit the learner will enable to understand,

- the difference between sentence and proposition,
- categorical propositions and the types of propositions in classical and modern logic.
- four kinds of categorical propositions and the structure of standard form categorical proposition.

5.1 INTRODUCTION

The theory of categorical propositions takes the central position in Logic. It was given by Aristotle more than 2000 years ago. The importance of this contribution lasts even today as in our day to day ordinary life we either use categorical propositions or sentences, which are easily translatable into categorical propositions. Categorical propositions are the building blocks or constituents of a categorical syllogism; the fundamental form of argument used in human reasoning. Logical reasoning is concerned with constructing arguments, analyzing the structure of arguments and evaluating them to check whether they are valid or invalid. All arguments are built with propositions. Let us begin the unit by examining the concept of a proposition.

5.2 PROPOSITION

In logic the unit of reasoning is called proposition. A proposition is either asserted or denied. Both premises and conclusion in an argument are propositions. Proposition is a declarative statement of facts, which asserts that something is (or is not) the case, and therefore it is either true or false. For example, ‘Dogs are mammals’, ‘Pigeons are birds’, ‘Knives are sharp objects’ etc. It is important to distinguish a proposition from a sentence. Sentence is a grammatical unit expressed in any particular language. A proposition is different from imperative, exclamatory or interrogative sentences. Although questions are asked, commands are given and exclamations are uttered but unlike a proposition they cannot be asserted or denied. Truth and falsity are applied to propositions and do not apply to questions, commands and exclamations. Although interrogative sentences are in the form of a question, like, Did Rohan come to class today?, Will you have lunch with me today? which can be answered in either yes or no but they are neither true nor false. Similarly, imperative sentences are in the form of a command, like, Give me a glass of water! Open the door! which can neither be true nor false. Moreover, exclamatory sentences, like, Hurray! we won the match, Wow! that was a great song and others can neither be true nor false. It is significant to note that an essential feature of being a proposition is that it is either true or false. Only informative, declarative and factual sentences are propositions. However, we might not know about the truth or falsity of a given proposition. A proposition is true when it describes the facts correctly and false when it does not. For example, although at present, due to limited research, we are unaware about the truth or falsity of the proposition, 'The corona virus is curable' but it is certain that either it is true i.e. there is a cure for the virus or it is false i.e. the virus is incurable.

Furthermore, two sentences can be used to assert or deny the same proposition. Given the same context, two sentences, which are composed of different words and arranged differently, have the same meaning. We take two sentences;
Playing hockey is known to Sushma.
Sushma knows to play hockey.
These two declarative sentences have exactly the same meaning despite being two different sentences on several counts, like, first contains 6 words and second contains 5 words, they begin with different words etc. Also, the same sentence can be used in different contexts to make very different statements. On change in the temporal context the same sentence can give rise to different propositions. Propositions may be simple as well as compound. Moreover, a sentence is a sentence in the particular language in which it is used. However, Propositions are not peculiar to any language. A given proposition can be asserted in many languages. For example;
It is snowing. (English)
Il neige. (French)
பனி பொழிகிறது (Tamil)

برف باري ٿي رهي آ (Sindhi)

बर्फ गिर रही है| (Hindi)

All the five sentences in English, French, Tamil, Sindhi and Hindi languages mentioned above are certainly different as they are sentences in different languages. Still they have the same meaning and are uttered to assert the same proposition “It is snowing.” Also, the composition of same words can be used to assert different propositions at different times. Some writers prefer the word “statement” instead of “proposition.” However, for our purpose we shall use the term “proposition.”

Historically, in order to provide us with techniques to discriminate between valid and invalid arguments two types of theories have been developed.

1. “Classical” or “Aristotelian Logic”
2. “Modern” or “Modern Symbolic Logic”

5.2.1 “Classical” or “Aristotelian Logic”

Classical Logic is named after Aristotle, the ancient Greek philosopher. Aristotle has contributed to nearly all fields of human knowledge. He is known as the founder of logic and one of the first scholars to systematically study propositions and arguments. His works on reasoning are gathered under the name *Organon*. *Organon* contains the subject matter of Classical Logic. In the present block and unit we shall develop an understanding of Classical Logic.

5.3 CONCEPT OF PROPOSITION IN CLASSICAL LOGIC

Propositions are building blocks of every argument. A proposition carries a subject term, a predicate term and a copula. For example, in the proposition “Cats are mammals”, ‘Cats’ is subject, ‘mammals’ is predicate and ‘is’ is copula. On the basis of truth value there are three kinds of propositions. A proposition which is always true is a called **tautology**. For example, “Men are mortal”, “No squares are circles”, “Dogs are mammals” etc. A proposition which is always false is called **contradictory** or self contradictory. For example, “Men are immortal”, “Hydrogen is Nitrogen”, “All triangles are circles” etc. A proposition which does not have a fixed truth value, i.e. is true in some case and false in some others, is called **contingent**. For

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example, “It is cold”, “Ram is the most intelligent boy in the town”, might be true right now but they may be false at a different time.

Traditionally, philosophers have divided propositions into two groups:

1. Categorical Propositions
2. Conditional Propositions

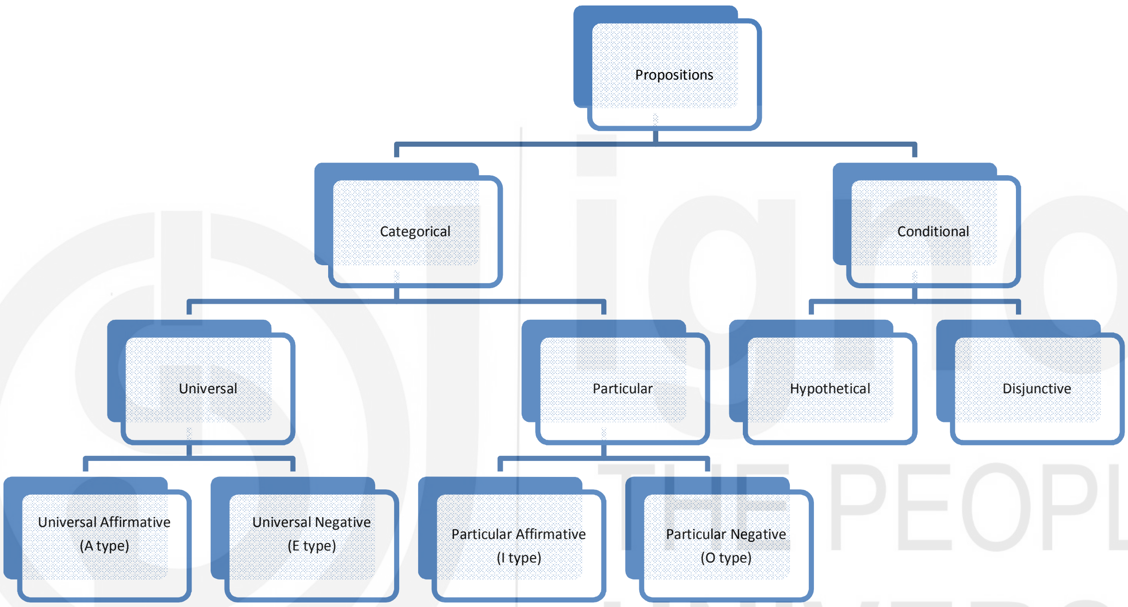
Propositions
Categorical
Conditional
Universal
Particular
Hypothetical
Disjunctive
Universal Affirmative (A type)
Universal Negative (E type)
Particular Affirmative (I type)
Particular Negative (O type)

Figure1: Traditional Classification of Propositions (Jain, 2014, p.37)

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Categorical propositions are subject of our discussion in the present unit. We shall briefly explain conditional propositions i.e. Hypothetical propositions and Disjunctive propositions in the modern classification of propositions.

5.4 CONCEPT OF A PROPOSITION IN MODERN LOGIC

Modern Logic has its origin in the first half of the nineteenth century. Unlike traditional Logic, Modern logicians move beyond the traditional methods, principles and rules of deriving validity and invalidity of an argument. George Boole, Alferd North Whitehead, Bertrand Russell are prominent Modern Logicians. Modern Logic is used to test the validity of all variety of arguments. Its methods are used in computers, electric switching circuits, artificial intelligence and other modern day technology. The modern logicians broadly accept the traditional account of propositions but their classification is different from them. This difference is due to existential import of the propositions. We shall study the concept of existential import in a separate unit of this block. Modern logicians have given the following classification of propositions:

1. Categorical Propositions
    A. Singular (simple)
    B. General
2. Compound Propositions

5.4.1 Categorical Propositions

5.4.1.1 Singular Propositions: A categorical proposition is singular when the subject term of the proposition is a proper name or one specific individual or object. Few examples are, "Raman is student of this College", "Himalayas are the highest mountain ranges in the world", "Gita is daughter of Lakshmi" etc.

5.4.1.2 General Propositions: In case of a general proposition the subject refers either to all members of a class or to some members of a class. There are two types of generalizations; either universal or particular. In the next section on categorical proposition we will see universal and particular propositions can be of two types depending on whether they affirm or deny the case (refer to fig.2) Traditional logicians add general propositions under universal propositions without ascribing any special status to them. However, singular propositions are neither universal nor particular but they have a unique status.

Furthermore, traditionally logicians, like, Aristotle have recognized that there is only one form of categorical proposition i.e. "Subject-Predicate form" (form which ascribes predicate to a subject). However, apart from this other relations can exist between subject and predicate of a singular proposition. Let us take few examples:

1. Raman is a hardworking student.
2. Raman is daughter of Lakshmi.
3. Raman is younger sister of Shubham.

According to modern logicians the first proposition has “subject-predicate form.” “Raman” is the subject and the predicate “a hard working student” is ascribed to him. The other two propositions are relational propositions i.e. they state that the two things have a certain relation with each other. In the second, Raman and Lakshmi have daughter-mother relation with each other. In the third, Raman and Shubham are related as sister and brother with each other. These relational propositions can never be reduced to subject-predicate propositions and are fundamentally different from them.

5.4.2 Compound Propositions

A compound proposition is constructed by two or more categorical propositions. Compound propositions are of three kinds:

5.4.2.1 Conjunctive Propositions: Two categorical propositions joined by ‘and’ give rise to conjunctive proposition. For example, “Krishna is polite and intelligent”, “Rekha is curious and funny” etc.

5.4.2.2 Disjunctive Propositions: When two categorical propositions are joined by the relation of ‘either or’ then it is called disjunctive proposition. For example, “Either Ram is in class or he is in the medical room”, “Either I will have apple or I will have banana” etc.

5.4.2.3 Hypothetical Propositions: When two categorical propositions are joined by ‘if then’ relation then they produce a hypothetical proposition. For example, “If I get this job then I can buy a car”, “If we go out then we can go mountain climbing” etc. (Jain, 2014, p.61-63)

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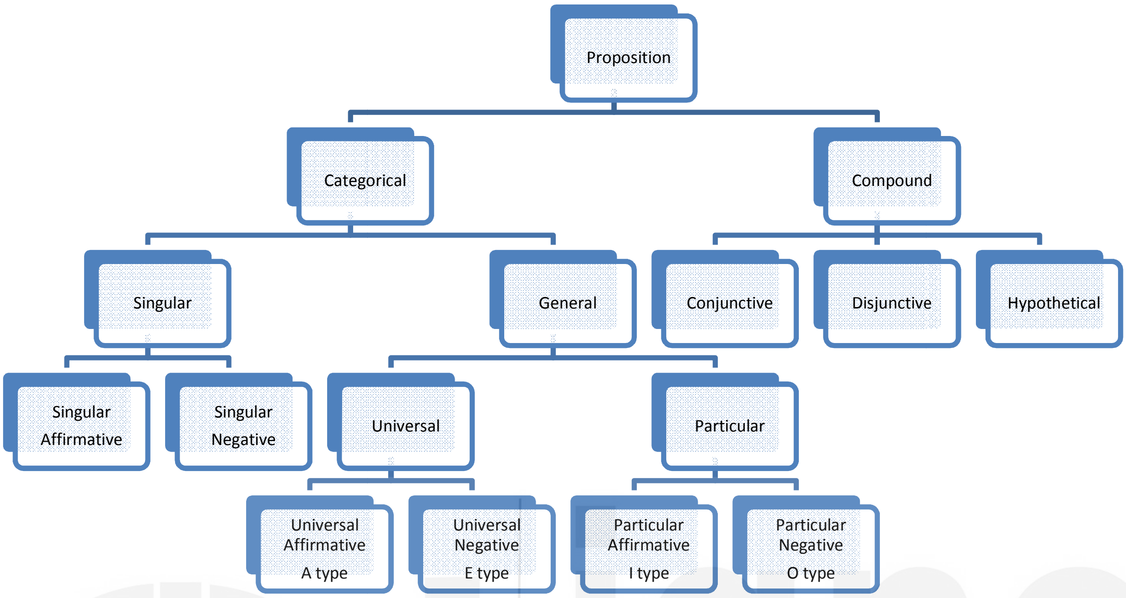

Figure 2: Modern Classification of Propositions (Jain, 2014, p.63)

Check your Progress I

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

1. Write a note on the following:

   a) Modern categorization of propositions

5.5 CATEGORICAL PROPOSITIONS

In Classical or Aristotelian logic the deductive reasoning focuses on analyzing arguments which carry propositions of a distinct variety, namely, categorical propositions. Categorical propositions are building blocks of classical theory of deduction as they are fundamental units which form a Categorical syllogism. A Categorical proposition is a proposition which relates to classes or categories. These classes are denoted by subject terms and predicate terms. **Class** is understood as a collection of all objects that have a common specific characteristic. Categorical propositions either affirm or deny, that all or part of the class denoted by the subject term S is included in or excluded from the class denoted by the predicate term P. Let us take example of an argument to understand the relation between subject and predicate terms in categorical propositions:

All philosophers are scientists.
Some philosophers are mathematicians.
Therefore, some mathematicians are scientists.

All three propositions used in this argument, both premises and conclusion are categorical propositions. All three categorical propositions are about classes; class of all philosophers, class of some mathematicians and class of some scientists. The first proposition asserts that the entire class of philosophers is included in the class of scientists. The second proposition asserts that some members of the class of philosophers are also members of the class of mathematicians. The third proposition asserts that some members of the class of mathematicians are also members of the class of scientists.

Introduction to Logic identifies three ways in which classes may be related to one another.

1. If every member of one class is also a member of a second class, like the class of lizards and the class of reptiles, then the first class is said to be included or contained in the second.
2. If the two classes have no members in common, like the class of all buildings and the class of all plants, the two classes may be said to exclude one another.
3. If some members but not all of them are also members of another, like the class of hockey players and class of athletes, then the first class may be said to be partially contained in the second class. (Copi et al., 2016, p.101)

All these various relationships between classes are affirmed or denied by categorical propositions. Based on these relationships we have exactly four types of categorical propositions.

5.6 THE FOUR KINDS OF STANDARD FORM CATEGORICAL PROPOSITIONS

A standard form categorical proposition expresses the relation between the two classes with complete clarity. For a categorical proposition to be in standard form it has to be a substitution instance of one of the four forms given below:

1. Universal Affirmative Proposition: All S are P.
2. Universal Negative Proposition: No S is P.
3. Particular Affirmative Proposition: Some S is P.
4. Particular Negative Proposition: Some S is not P.

The letters S and P represent the subject and the predicate terms. Let us examine each standard form categorical proposition.

5.6.1 Universal Affirmative Proposition

A universal affirmative proposition asserts that every member of the first class is also a member of the second class. We should note that the opposite is not true. For example, ‘All scientists are philosophers.’ This proposition is about two classes scientists and philosophers and says that the subject term; class of scientists is included in the predicate term i.e. class of philosophers entirely. The name “Universal Affirmative” signifies that the whole subject class is included in the predicate class. The relationship of class inclusion holds between these two classes and class inclusion is complete or universal. Hence, all members of S are members of P.

5.6.2 Universal Negative Proposition

A universal negative proposition asserts that the first class is wholly excluded from the second class. For example, ‘No scientists are philosophers.’ The proposition claims that there is no member of class of scientists who is also a member of the class of philosophers. It denies universally that scientists are philosophers. The name “Universal Negative” signifies that the proposition denies that the relation of class inclusion holds between the two classes and denies it universally. Hence, no members of S are members of P.

5.6.3 Particular Affirmative Proposition

A particular affirmative proposition asserts that at least one member of the class designated by the subject term S is also a member of the class designated by the predicate term P. For example, ‘Some scientists are philosophers.’ Some members of the class of all scientists are also members of the class of all philosophers. But they do not affirm this class inclusion of all scientists as philosophers universally. Not all scientists universally but some particular scientists are said to be philosophers. However, it is important to note here that the word ‘some’ is indefinite in meaning. There is an ambiguity in defining the meaning of the word as it can be taken to indicate a whole range of meanings like, at least one, at least two, at least a hundred and many more. In our day-to-day usage the meaning of the term is determined by context of usage. In logic, it is customary to regard the word ‘some’ as meaning ‘at least one.’ The name “particular affirmative” signifies that the proposition affirms that the relationship of class inclusion holds; does not affirm it of the subject class universally but only partially, of some particular member or members of the subject class. Hence, some members of S are members of P.

5.6.4 Particular Negative Proposition

A particular negative proposition affirms that at least one member of the class designated by the subject term S is excluded from the whole of the class designated by the predicate term P. For example, ‘Some scientists are not philosophers.’ Like the Particular Affirmative Proposition this proposition is particular in as much as one does not refer to scientists universally being philosophers but at least one member or some members of that class. The name “particular negative” signifies that the proposition denies that the relationship of class inclusion does not hold for the subject class universally but only partially, of some particular member or members of subject class. Unlike the particular affirmative propositions, which affirm that the particular member or members of the subject class referred to are included in the predicate class, the particular negative propositions deny it. Hence, some members of S are not members of P.

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Patrick J. Hurley and Lori Watson in their book *A Concise Introduction to Logic* argue that since the early middle ages the four kinds of categorical propositions have commonly been designated by letter names corresponding to the first four vowels of the Roman alphabet: A E I O.

Universal affirmative propositions	Called A propositions
Universal negative propositions	Called E propositions
Particular affirmative propositions	Called I propositions
Particular negative propositions	Called O propositions

Traditionally, it is believed that these letters were derived from the first two vowels in the Latin words; Affirm and Nego.

- Affirm (“I affirm”)
- Nego (“I deny”)

		n
UNIVERSAL	**A**	**E**
	f	
	f	g
PARTICULAR	**I**	**O**
	r	
	m	
	o	

Table 1: source: (Hurley and Watson, 2019, p. 211)

Check your Progress II

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

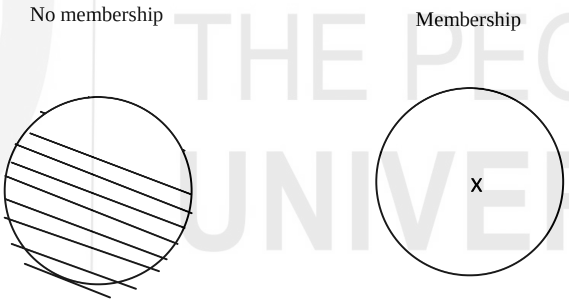
1. Write a note on the following:

a) Categorical Proposition

5.7 VENN DIAGRAMMATICAL REPRESENTATION

English logician and mathematician John Venn (1834-1923) invented Venn Diagrams. These diagrams are used to graphically exhibit each and every categorical proposition. The categorical propositions can be diagrammatical represented with the usage of two interlocking circles, which stand for two classes involved. The visual representation of the class relationships within a categorical proposition is shown with the technique of shading in case of no member to show the class empty. The figure below shows the shaded portion stands for no membership in a class and the presence of members in a class is designated by ‘x’. Moreover, we shall discover in the upcoming units that Venn Diagrams are extremely useful in appraising the validity of categorical arguments.

Figure 3



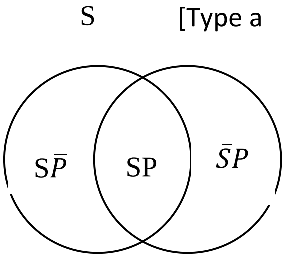
We label circle S, for “subject class”, and the other circle P, for “predicate class.”

Symbols $\bar{S}$ and $\bar{P}$ and used to indicate the regions which are “not S” and “not A”. They are called S-bar and A-bar indicating the overbar on top of the letter symbols. These symbols refer to complementary classes. We shall understand the concept of a complementary class in the upcoming unit. In this unit, we shall use the two symbols to understand the regions as illustrated in the figure:

Symbol $\bar{S}$ designates the region which is ‘not S.’

Symbol $\bar{P}$ designates the region which is ‘not P.’

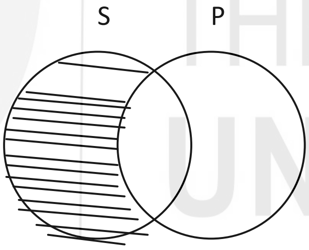
Figure 4



5.7.1 Universal Affirmative Propositions

The A proposition asserts, “All students are hard working people”. Our diagrammatical representation shows that there is a portion of S which is included in P. The figure designates that all members of class S are members of class P. Also, the diagram shows $S\bar{P}$ (that portion of S that stands outside of P) is shaded out, indicating that there are no members of S that are not members of P. The A proposition is diagrammatically represented in the following manner:

Figure 5: All S is P



5.7.2 Universal Negative Propositions

An E Proposition “No students are hardworking people” universally denies that any member of class of students is a member of the class of hardworking people. The diagram exhibits this mutual exclusion by shading out SP (overlapping portion of the two circles representing S and P classes) indicating that there are no members in the common area between S and P. The E proposition is diagrammatically represented in the following manner:

S P

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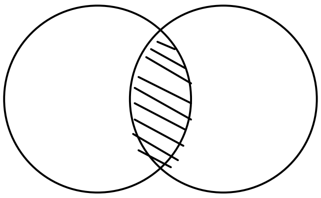
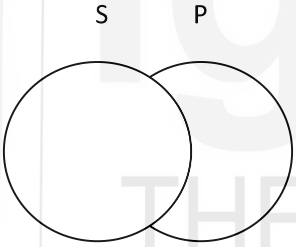
Figure 6: No S is P



5.7.3 Particular Affirmative Propositions

An I Proposition “Some students are hardworking people” asserts that there is at least one member of the class of students who is also a member of the class of hardworking people. Membership is shown by placing an x in SP (the overlapping region between the two circles) indicating that there is at least one member in the common area between the two classes. I proposition is diagrammatically represented in the following manner:

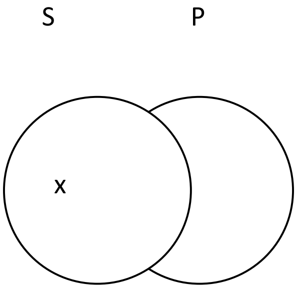
Figure 7: Some S is P



5.7.4 Particular Negative Propositions

An O proposition “Some students are not hard working” states that there is at least one member in the class of students who is not a member of class of hardworking people. The diagram indicates that there is at least one member of S that is not a member of P. This is shown by placing an x in $S\bar{P}$ (the region of S that is outside of P) indicating that there is at least one member in the region of S which is not a region of P. O proposition is diagrammatically represented in the following manner:

Figure 8: Some S is not P



Moreover, we should note few important points about the Categorical Propositions:

- Many times we find categorical propositions are not in standard form. Not all standard form categorical propositions are as simple and clear as the four examples discussed above. Many times they do not straight away begin with the words “all”, “no”, or “some”. For example, ‘Dogs are mammals’, ‘Few horses are white’ etc. In Unit 3 we shall discuss the translation of such categorical propositions to standard form. Also, at times the subject and predicate terms of categorical propositions are expressed in a complicated manner. For example, “All S are not P” is not even a standard form categorical proposition.
- Words “all”, “no” and “some” are referred to as quantifiers as they tell us how much of the subject class is included in and excluded from the predicate class. “All” as a quantifier tell us that the whole subject class is included in the predicate class. “No” as a quantifier tells us that the whole subject class is excluded from the predicate class. In affirmative categorical propositions “Some” as a quantifier tells us that at least one member of the subject class is included in the predicate class. In negative categorical propositions “some” as a quantifier tells us that at least one member of the subject class is excluded from the predicate class. There are exactly three forms of quantifiers (“All”, “No” and “Some”). The next unit will discuss issues of Quality, Quantity and Distribution in details.
- There is a difference between “subject” and “subject term” as well as “predicate” and “predicate term.” What we mean by “subject” and “predicate” in grammar is not the same with what we mean by “predicate term” and “subject term” in Logic. Let us take an example to understand this distinction; “All graduates of Indian Military academy are commissioned officers in Indian Army.” For grammatical purposes the “subject” of the above proposition would be “All graduates of Indian Military academy” which would include the quantifier. Also, for grammatical purpose the “predicate” of the above proposition would be “are commissioned officers in Indian Army” which would include the copula. (Hurley and Watson, 2016, p.207-208)

5.8 GENERAL SCHEMA OF STANDARD FORM CATEGORICAL PROPOSITION

Standard form categorical propositions have four separate components which do not overlap. The letters S and P stand for the subject and predicate terms respectively. Between the subject and the predicate of every standard form categorical propositions stands form of the verb “to be.” Words “are” and “are not” are called copula because they connect the subject term with the predicate term. In a standard form categorical proposition forms of copula can be various forms of verbs “to be” such as “is”, “is not”, “will”, “will not”, “are”, “are not”.

For example;

- All whales are mammals.
- Some freedom fighters were teachers in primary schools.
- Some refugees will not get jobs.

In the propositions mentioned above “are, “were” “will” serve as copulas. However, to maintain the unity of form in categorical propositions all units in this block only use two varieties of copula “are” and “are not.” The general schema of a standard form categorical proposition is composed of four parts. In a proposition: first comes the quantifier, secondly the subject term, thirdly the copula, and finally the predicate term.

The schema is represented as:

Quantifier (subject term) copula (predicate term)

*****In case of a particular negative proposition there is also a negation (mostly ‘not’) after copula and before predicate term.

Analysis of Standard form categorical proposition is done in the following manner:

All graduates of Indian Military Academy are commissioned officers in Indian Army.

Quantifier: all

Subject term: graduates of Indian Military Academy

Copula: are

Predicate term: commissioned officers in Indian Army

Check your progress III

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

1. Identify the subject term, predicate term, quantifier and copula in the following categorical propositions:

1. All animal rights activists are people who are motivated by empathy.
2. Some mangoes are not sweet fruits.
3. Some knives are sharp objects.
4. No bachelors are married men.
5. All trucks are vehicles.
6. No roses are marigolds.
7. Some dogs are pets.
8. Some grapes are sour fruits.
9. All buses are vehicles.
10. All reality TV stars are rich people.

5.9 LET US SUM UP

Our discussion on categorical propositions is summed up with the help of the table below:

Proposition form	**Name and Type**	**Example**
All S is P	Universal Affirmative A	All dogs are mammals
No S is P	Universal Negative E	No cats are dogs
Some S is P	Particular Affirmative I	Some dogs are pets
Some S is not P	Particular Negative O	Some dogs are not pets

5.10 KEY WORDS

Class: Class is a collection of all objects that have some specific characteristic in common. Eg. ‘dogs’, ‘tables’, ‘animals’, ‘fishes’ and others.

Categorical Proposition: A proposition that is about classes or categories, which affirm or deny that either in whole or in part one class S is included in some other class P.

Venn diagram: Diagrammatical representation of a categorical proposition which is used to display their logical forms by means of overlapping circles.

5.11 FURTHER READINGS AND REFERENCES

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5.12 ANSWERS TO CHECK YOUR PROGRESS

Check your Progress I

1. Compound Propositions

A compound proposition is constructed by two or more categorical propositions (singular or general). They are of three kinds:

A. Conjunctive
B. Disjunctive
C. Hypothetical

A. Conjunctive Propositions: Two Categorical propositions joined by ‘and’ make conjunctive compound propositions. For example, “Tiger roars and is carnivorous.”

B. Disjunctive Propositions: When two categorical propositions are joined by the relation of ‘either or’, then it is called disjunctive proposition. For example, “Either Sheila is in the gym or she is in the library.”

C. Hypothetical Propositions: When two Categorical propositions are joined by ‘if then’ relation then it produces a hypothetical proposition. For example, “If I get admission to Fashion Designing course then I can start my own Boutique.”

Check your Progress II

1.

Categorical propositions are building blocks of classical theory of deduction as they are fundamental units which form a categorical syllogism. A Categorical proposition is a proposition which relates two classes or categories. These classes are denoted by subject terms and predicate terms. Class is understood as a collection of all objects that have a specific characteristic in common. Categorical propositions either affirm or deny, that all or part of the class denoted by the subject term S is included in or excluded from the class denoted by the predicate term P. Let us take example of an argument:

All rabbits are fast runners.
Some horses are fast runners.
Therefore, some horses are rabbits.

All three propositions used in this argument, both premises and conclusion are categorical propositions. All three categorical propositions are about classes; class of all rabbits, class of some horses and class of some fast runners. The first proposition asserts that the entire class of rabbits is included in the class of fast runners. The second proposition asserts that some members of the class of horses are also members of the class of fast runners. The third proposition asserts that some members of the class of horses are also members of the class of rabbits. Based on relation of exclusion or inclusion between classes as affirmed or denied by categorical propositions we have exactly four types of categorical propositions:

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1. Universal Affirmative Propositions
2. Universal Negative Propositions
3. Particular Affirmative Propositions
4. Particular Negative Propositions

Check your Progress III

1.

1. All animal rights activists are people who are motivated by empathy.

Subject Term: Animal rights activists

Predicate Term: people who are motivated by empathy

Quantifier: All

Copula: are

2. Some mangoes are not sweet fruits.

Subject Term: Mangoes

Predicate Term: sweet fruits

Quantifier: some

Copula: are

3. Some knives are sharp objects.

Subject Term: knives

Predicate Term: sharp objects

Quantifier: some

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Copula: are

4. No bachelors are married men.

Subject Term: bachelors

Predicate Term: married men

Quantifier: No

Copula: are

5. All trucks are vehicles.

Subject Term: Trucks

Predicate Term: vehicles

Quantifier: All

Copula: are

6. No roses are marigolds.

Subject Term: Roses

Predicate Term: Marigolds

Quantifier: No

Copula: are

7. Some dogs are pets.

Subject Term: dogs

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Predicate Term: pets

Quantifier: Some

Copula: are

8. Some grapes are sour fruits.

Subject Term: grapes

Predicate Term: sour fruits

Quantifier: Some

Copula: are

9. All buses are vehicles.

Subject Term: buses

Predicate Term: vehicles

Quantifier: all

Copula: are

10. All reality TV stars are rich people.

Subject Term: reality TV stars

Predicate Term: rich people

Quantifier: All

Copula: are

UNIT 2 QUALITY, QUANTITY, AND DISTRIBUTION[*]

Structure

6.0 Objectives

6.1 Introduction

6.2 Quality

6.3 Quantity

6.4 Concept of Term

6.5 Types of Terms

6.6 Connotation and Denotation of Terms

6.7 Distribution of Terms

6.8 Let Us Sum Up

6.9 Key Words
6.10 Further Readings and References
6.11 Answers to Check Your Progress

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6.0 OBJECTIVES

In the present unit our objective is to develop a clear understanding of the structure of a standard form categorical proposition.

In this unit we shall,

- methodically enumerate two essential attributes of a categorical proposition:

    1. Quality

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2. Quantity

- understand the meaning of ‘term’ and its various kinds.
- acquire an in-depth understanding of ‘distribution of terms’ depending on the quality and quantity in a standard form categorical proposition.

6.1 INTRODUCTION

Categorical Propositions are of four kinds depending on Quality, Quantity and Distribution of terms in them. We observe that the nomenclature used to refer to standard form categorical propositions describes every one of the four standard forms by first mentioning its quantity and second its quality namely; “Universal Affirmative”, “Universal Negative” “Particular Affirmative” and “Particular Negative.” In order to illustrate how quality and quantity are attributes pertaining to categorical propositions let us begin the unit with the help of illustrating a table.

Nomenclature	Proposition
Universal Affirmative	All S are P
Universal Negative	No S are P
Particular Affirmative	Some S are P
Particular Negative	Some S are not P

Table 1

6.2 QUALITY

Quality is an attribute of a categorical proposition. Every standard form Categorical Proposition has a quality, which is either *affirmative* or *negative*. If the proposition affirms some class membership, whether complete or partial, it possesses affirmative quality. However, if the proposition denies class membership, whether complete or partial, it possesses negative quality. Both universal affirmative propositions “All S are P” and particular affirmative propositions “Some S are P” are affirmative in quality. They are called *Affirmative Propositions.* Both universal negative propositions “No S are P” and particular negative propositions “Some S are not P” are negative in quality. They are called *Negative Propositions*.

Let us illustrate characterization of quality with the help of a table:

Proposition Type	**Proposition form**	**Example**	**Quality**
A	All S is P	All dogs are mammals.	Affirmative
E	No S is P	No dogs are cats.	Negative
I	Some S is P	Some cats are pets.	Affirmative
O	Some S is not P	Some dogs are not pets.	Negative

Table 2

6.3 QUANTITY

Like Quality Quantity is also an attribute of a categorical proposition. Every categorical proposition has a quantity either *universal* or *particular*. Quantity depends on whether the statement makes a claim about every member of the class denoted by the subject term or only some members of the class denoted by the subject term. If the proposition refers to all members of the class designated by its subject term, it possesses ‘universal’ quantity. However, if the proposition refers only to some members of the class designated by its subject term, it possesses ‘particular’ quality.

Both universal affirmative proposition “All S are P” and universal negative proposition “No S are P” are universal in quantity. They assert something about every member of the S class and therefore are *universal propositions.* These propositions assert that every member of the subject class is either universally included in or is universally excluded from members of the predicate class.

Both particular affirmative proposition “Some S are P” and particular negative proposition “Some S are not P” are particular in quantity. They assert something about some members (one or more members) of the S class and therefore they are *particular propositions.* These propositions make a limited claim that some members of their subject class are either included in or excluded from members of predicate class.

Let us illustrate characterization of quantity with the help of a table:

Proposition Type	**Proposition form**	**Example**	**Quantity**
A	All S is P	All spiders are eight legged creatures.	Universal
E	No S is P	No dogs are eight legged creatures.	Universal
I	Some S is P	Some Indians are conservatives.	Particular
O	Some S is not P	Some Indians are not Conservatives.	Particular

Table 3

It is worthy to note that all categorical propositions begin with the words, which show there quantity; “All”, “No”, “Some.” “All” and “No” indicate that the quantity is universal, “Some” indicates that the quantity is particular. Quantity of a categorical proposition can be determined by merely seeing the quantifier. For example; by seeing “All” and “No” we understand that the proposition is universal and by looking at “some” we realize that the proposition is particular. Also, the quantifier “no” adds the indication of negative quality of E proposition.

However, Categorical Propositions have no “qualifier.” In the case of Universal Propositions we can determine the quality by looking at the quantifier. For e.g. we identify that the quality of E proposition is negative by looking at “no”, which is also a quantifier. However, in case of particular propositions the quality can be known by looking at the copula. For e.g. in particular proposition “Some S is P” copula is “is”, which showcases that the quality is affirmative and in particular proposition “Some S is not P” copula is “is not”, which showcases that the quality is negative (Copi et al., 2016, p. 107). We can summarise the above section with the help of a table:

Categorical Proposition	**Letter Indication**	**Quantity Quantity**

All S are P	A	Universal Affirmative
No S are P	E	Universal Negative
Some S are P	I	Particular Affirmative
Some S are not P	O	Particular Negative

Table 4

The meaning of the notations of quality and quantity can be understood in class terminology through the following table:

	Proposition	**Meaning in Class Notation**
A	All S are P	Every Member of the S class is a member of the P class; that is, the S class is included in the P class.
E	No S are P	No member of the S class is a member of the P class; that is S class is excluded from the P class.
I	Some S are P	At least one member of the S class is a member of the P class.
O	Some S are not P	At least one member of the S class is not a member of the P class.

Table 5 Source: (Hurley and Watson, 2016, p.211)

Check your Progress I

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

1. Write a note on,

Quality of a standard form categorical proposition

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2. State the Quality and Quantity of the following categorical propositions.

1. Some students are hardworking people.
2. All teachers are government servants.
3. No birds are reptiles.
4. All lizards are reptiles.
5. Some engineers are not talented.
6. All fast foods items are unhealthy.
7. No restaurants are safe places.
8. Some laptop screens are flexible.
9. Some movies are not based on true stories.
10. All festivals are joyous occasions.

6.4 THE CONCEPT OF TERM

We have already discussed the distinction between ‘subject’ and ‘subject term’ as well as ‘predicate’ and ‘predicate term’ in the previous unit. Before developing an understanding of distribution of terms we first begin by understanding the meaning of term. A word or a group of words which are ‘subject’ or ‘predicate’ of a proposition are called terms. A ‘term’ must have both a definite meaning and it should be either a subject or a predicate of a proposition. There are two terms in each standard form categorical proposition. Historically, the word 'term' has its origins in the latin word *terminus* i.e. a limit or a boundary. In a way a 'term' limits our thought as it clearly defines the meaning of a word. Let us analyze the example of following categorical proposition:

All dogs are mammals.

This proposition comprises of four words, namely; 'all', 'dogs', 'are', and 'mammals.' 'Dogs' and 'mammals' are words, which qualify as terms. While all terms are words but all words are not terms.

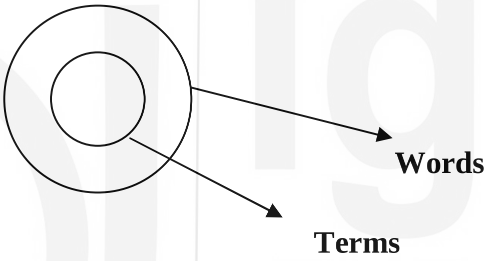

Figure: 1

Moreover, there are three significant concepts to understand in order to explain the functioning of a term:

1. Types of terms
2. Distribution of Terms
3. Denotation and Connotation of terms

6.5 TYPES OF TERMS

Logician Dr. Krishna Jain in her book, *A Textbook of Logic* argues that logicians have classified terms into four broader groups. However, it should be noted that one term can belong to two or more categories. These categories are:

A. Singular and General Terms
B. Concrete and Abstract Terms

C. Positive and Negative Terms
D. Collective and Distributive Terms

6.5.1 Singular and General Terms

With a singular term we refer to one single or specific person, object or thing. Examples of singular terms are Mohan, Geeta, Bangalore, this table, that cycle, I etc. Singular terms are of two types:

1. Proper names or nouns: All proper nouns used in propositions either as a subject or as a predicate are called singular terms. For instance school, college, nursery, mouse etc.
2. Specifically or uniquely described term: Specifically described terms refer to single person or object. Although they are not proper names nonetheless they refer to a unique reference. "The Prime Minister of India in 1962 Indo-China War" has a unique reference because it refers to a unique person 'Mr. Jawaharlal Nehru'.

On the other hand when a common noun is used as a 'term' in a proposition it is called a general term. In the proposition 'Hospital is a public institution', the term 'hospital' is used as a common or general term.

6.5.2 Concrete and Abstract Terms

Concrete terms refer to objects, things, persons and articles like, rat, table, copy, box, tree, man and others. On the other hand, abstract terms refer to abstract entities i.e. numbers, classes, attributes or characteristics in themselves. Examples of abstract terms are Happiness, Sadness, Cowness, Oneness, Blueness etc. However, we should clarify at this stage that although 'sadness' is an abstract term but 'sad' is not (it is an adjective). However, depending on the context the same term can be used as a concrete or abstract term. Let us consider two uses of the term "Basketball team":

- Basketball team got aggressive.
- Basketball team teaches discipline.

In the first proposition the term "basketball team" is used as a concrete term because we are referring to a particular team whereas in the second proposition it is used as an abstract term because we are referring to the term conceptually.

At this juncture it is important to note that in a categorical proposition both subject and predicate terms are nouns. If either of the terms is not noun then it should be changed in appropriate noun so that it becomes a concrete term. Let us take an example: “Mangoes are yellow” is reduced to “Mangoes are yellow objects”. Both subject term “mangoes” and predicate term “yellow objects” are concrete terms. We shall discuss more on converting a proposition into standard form categorical proposition in Unit 3; “Translating Categorical Propositions into Standard Form.”

6.5.3 Positive and Negative Terms

Positive terms affirm presence of an attribute but negative terms deny the presence of an attribute. Examples of positive terms are happy, moral, true, citizen etc. However, negative terms are shown by examples like unhappy, immoral, false etc. We shall qualify that although there are negative propositions, like, “Some men are not moral” but there can also be an affirmative proposition with a negative predicate, like, “Some men are immoral.” We shall explore more about this distinction in Unit 4 on Immediate Inferences.

6.5.4 Collective and Distributive Terms

Collective terms are applicable on group of persons, objects or things where the entire class is taken into consideration. For example terms like, university, country, laboratory etc are collective terms. However, distributive terms refer to all the members of the class separately i.e. individuals who compose the group. No term is collective or distributive in itself. Instead it is the use of the term in the proposition, which decides whether the term is used in a collective or distributive manner (Jain, 2014, p. 74-77)

6.6 CONNOTATION AND DENOTATION OF TERMS

In formal logic in order to make our reasoning valid we need to make sure that the meaning of terms used in our reasoning should be absolutely clear. There are two different techniques for the same namely; denotative and connotative techniques. It would be apt to say that “denotation denotes the objects, connotation connotes the characteristics.” (Jain, 2014, p.69)

Denotation of a term indicates all objects or persons referred by the term. For example; the denotation of the term ‘singer’ is Lata Mangeshkar, Asha Bhosle, Sonu Nigam, Anuradha Porwal etc.

Connotation of a term is the set of qualities and characteristics possessed by all objects or persons referred by the term. Connotation refers to those qualities, which are possessed by all the members who are denoted by the term. Let us consider example of connotation of the term ‘animal’. Although there might be a range of qualities or characteristics possessed by all animals but ‘mortality’ is an essential quality possessed by all. However, there are many other characteristics, which are inessential because they are not possessed by every animal. Animals can be broadly divided on the basis of their biological features into mammals, birds, reptiles, fish and amphibians. Each group possesses different characteristics, like, laying eggs, breathing through fins, breathing through lungs, scales on body, fur or hair on body, two legs, four legs, etc. Therefore, the connotation of a term refers to only those qualities, which are indispensible in providing meaningfulness to the term.

In the previous unit we were acclimatized with the concept of class. Let us reframe the concept of connotation and denotation in the context of class. A class consists of dual meaning; denotative and connotative. Let us take example of the class of men. The members belonging to the class of men, like, Rohan, Ojas, Mohan etc refer to denotation of the term ‘man.’ However, the class characteristics, like, rationality, mortality and others, which are possessed by every member of the class refer to the connotation of the term.

Moreover, it is significant to understand the relation between Denotation and Connotation of a term in terms of extension and intention. Denotative meaning of a term is referential or extensional because it refers to membership in a class and indicates the extent to which the term is applicable. On the other hand Connotative meaning of a term is intentional which means the intended characteristics of a term. Moreover, they are inseparably related. We gather that with increase in qualities (intension or connotation) the members (denotation or extension) decrease and with the decrease in the qualities (intension or connotation) the members (denotation or extension) increase. Also, we should note that it is the connotation, which determines denotation and not the other way round. The reason is that connotation is the set of characteristics, which fix members in a class. We can understand this relation with the help of an example. Despite of

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constant increase in the Denotation (the members) in animal population the connotation of the term ‘animal’ (the essential characteristic of ‘mortality’) has remained the same. Hence a term’s intention determines its extension and not vice-versa.

6.7 DISTRIBUTION OF TERMS

Distribution is an attribute of the subject and predicate terms of propositions. Distribution characterizes the manner in which subject and predicate terms occur in categorical propositions. As we move to Categorical Syllogism in the upcoming chapters, developing an understanding of distribution of terms becomes very important. The determination of distribution of terms in standard form categorical propositions helps in evaluating validity/ invalidity of Categorical Syllogisms. In the preceding sections we have discussed that the subject and the predicate terms of a standard form categorical proposition represent classes of objects. Every proposition is about these classes; a proposition may refer to either all members of a class or to some members of that class. A proposition distributes a subject or predicate term if it refers to all members of the class, which are designated by the term. Let us elucidate the distribution of subject and predicate terms in all the four standard-form categorical propositions.

6.7.1 Distribution of terms in Universal Affirmative Propositions

All soldiers are citizens.

The proposition asserts that each and every member of the class of soldiers is a citizen but does not state the reverse i.e. makes no such assertion about the class of citizens. It neither affirms nor denies anything about the class of citizens. The subject term of the A proposition is distributed by that proposition but the predicate term of A proposition is undistributed by it. This proposition refers to all members of the class designated by its subject term S. Therefore it distributes its subject term. However, it does not refer to all members of the class designated by its predicate term. And hence, the predicate term is undistributed in A proposition.

6.7.2 Distribution of terms in Universal Negative Propositions

No soldiers are cowards.

An E proposition asserts about each and every member; that if he is a soldier then he is not a coward. It says that the whole class of soldiers is excluded from the class of cowards as well as the whole class of cowards is excluded from the class of soldiers. Like the A proposition, E proposition distributes each and every member of its subject class therefore it distributes its subject term. But, unlike the A proposition which does not distribute its predicate term, E proposition distributes its predicate term. The proposition clearly asserts of each and every coward that he or she is not a soldier. Therefore, E proposition distributes both the subject and the predicate terms.

6.7.3 Distribution of Terms in Particular Affirmative Propositions

Some dogs are pets.

An I proposition makes no assertion whatsoever about the class of dogs and makes no assertion about the class of pets. The proposition makes no claims to inclusion or exclusion of all members of the class of dogs into the members of the class of pets. It neither says anything about each and every member of class of dogs nor about each and every member of class of pets. The proposition only suggests that there are some dogs (at least one), which are taken as pets. Therefore neither of the classes is wholly included or excluded from the other. Hence, in a particular affirmative proposition both subject and predicate terms are undistributed.

6.7.4 Distribution of terms in Particular Negative Propositions

Some musicians are not pianists.

An O proposition is similar to I proposition in as far as it does not distribute its subject term. The particular negative proposition says nothing about *all* musicians but asserts that *some* members of the class of musicians do not belong to the class of pianists. Some part of class of musicians is partly excluded from the whole of class of pianists. However, O propositions say that given the reference to some members of the class of musicians each and every member of the class of pianists is not one of those musicians. So, particular negative proposition distributes its predicate term but not its subject term.

We observe that both universal propositions distribute their subject terms but both particular propositions do not distribute their subject term. However, both affirmative propositions do not distribute their predicate term but both negative propositions distribute their predicate terms. We can also make the same point in terms of quantity and quality of propositions, which play a role in understanding the distribution of respective terms. The quality of a standard form categorical proposition determines whether it distributes the predicate term. The quantity of a standard form categorical proposition determines whether it distributes the subject term. To conclude,

A Proposition distributes only its subject term.

E Proposition distributes both subject and predicate terms.

I proposition distributes neither subject nor predicate term.

O proposition distributes only its predicate term.

We illustrate diagrammatically the distribution of terms in standard form categorical propositions:

Distribution of terms	**Predicate term undistributed**	**Predicate term distributed**
Subject term distributed	A: All S is P	E: No S is P
Subject term undistributed	I: Some S is P	O: Some S is not P

Table 6 Source: (Copi et al., 2016, p. 109)

Check your Progress II

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

Write a note on the following,

1. Connotation and Denotation of a term.

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2. State whether the subject and predicate terms in the following propositions are distributed or undistributed.

1. All goats are mammals.
2. Some buildings are tall.
3. Some fruits are not sweet.
4. All officers in the Indian navy are trained in swimming.
5. No government employee is illiterate.
6. All good services are expensive.
7. All tomatoes are sour.
8. Some fiction books are inspired by true-life events.
9. No hill stations are hot places.
10. Some curtains are not thick.

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6.8 LET US SUM UP

We can summarise the above discussion with the help of a table:

Proposition	**Letter**	**Quantity**	**Quality**	**Distribution**	**Distribution**

	Name			of Subject term	of Predicate term
All S are P	A	Universal	Affirmative	Yes	No
No S are P	E	Universal	Negative	Yes	Yes
Some S are P	I	Particular	Affirmative	No	No
Some S are not P	O	Particular	Negative	No	Yes

6.9 KEY WORDS

Distribution of terms: An attribute which describes the relationship between a categorical proposition and its subject and predicate terms. Distribution determines whether or not the proposition refers to every member of the class represented by a given term.

Quality: An attribute of every categorical proposition, determined depending on whether the proposition affirms or denies the class inclusion. Every categorical proposition has quality, which is either universal or particular.

Quantity: An attribute of every categorical proposition, determined depending on whether the proposition refers to all members or some members of the class designated by its subject term. Every categorical proposition has quantity which is either universal or particular.

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6.11 ANSWERS TO CHECK YOUR PROGRESS

Check your Progress I

1.

Quality is an attribute of a categorical proposition. Every standard form Categorical Proposition has a quality, which is either affirmative or negative. Eminent professors of Logic Irving M. Copi, Carl Cohen and Kenneth McMahon assert that if the proposition affirms some class membership, whether complete or partial, it possesses affirmative quality. However, if the proposition denies class membership, whether complete or partial, it possesses negative quality. Both universal affirmative propositions "All S are P" and particular affirmative propositions "Some S are P" are affirmative in quality. Both universal negative propositions "No S are P" and particular negative propositions "Some S are not P" are negative in quality. Following table can be drawn to show the quality of four standard-form categorical propositions.

Proposition Type	**Proposition form**	**Example**	**Quality**
A	All S is P	All cats are mammals.	Affirmative
E	No S is P	No shirts are skirts.	Negative
I	Some S is P	Some knives are sharp objects.	Affirmative
O	Some S is not P	Some books are not educational.	Negative

2.

1. Quality: Affirmative Quantity: Particular

2. Quality: Affirmative Quantity: Universal

3. Quality: Negative Quantity: Universal

4. Quality: Affirmative Quantity: Universal

5. Quality: Negative Quantity: Particular

6. Quality: Affirmative Quantity: Universal

7. Quality: Negative Quantity: Universal

8. Quality: Affirmative Quantity: Particular

9. Quality: Negative Quantity: Particular

10. Quality: Affirmative Quantity: Universal

Check your Progress II

1.

There are two different techniques to clarify the meaning of terms namely; denotative and connotative techniques. Denotation of a term is the object or person referred by the term. For example; the denotation of the term animal is cats, dogs, cows, tigers etc, the denotation of the term musician is, A. R. Rahman and others. Connotation of a term is the set of qualities and characteristics possessed by all objects or persons referred by the term. Connotation refers to those qualities, which are possessed by all the members denoted by the term. While Denotation denotes the objects and connotation connotes the characteristics possessed by the objects. The class of men has two fold aspects. The members belonging to the class of men say Rohit, Shyam, Gautam etc are denotation of the term man. However, the class characteristics like rationality, mortality and others, which are possessed by every member of the class are the connotation of the term.

The relation between Denotation and Connotation of a term can be understood in terms of its extension and intention. Denotative meaning of a term is referential or extentional as it refers to members of the class. In this sense Denotation indicates the extent to which the term is applicable. On the other hand Connotative meaning of a term is intentional which means the intended and indicated characteristics of a term. We can discuss them separately but they are inseperably related. We gather that with increase in qualities (connotation) the members (denotation) decrease. Similarly, with the decrease in the qualities (connotation) the members (denotation) increase.

2.

1. Subject: Distributed Predicate: Undistributed
2. Subject: Undistributed Predicate: Undistributed
3. Subject: Undistributed Predicate: Distributed
4. Subject: Undistributed Predicate: Undistributed
5. Subject: Distributed Predicate: Distributed
6. Subject: Distributed Predicate: Undistributed
7. Subject: Distributed Predicate: Undistributed
8. Subject: Undistributed Predicate: Undistributed
9. Subject: Distributed Predicate: Distributed
10. Subject: Undistributed Predicate: Distributed

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UNIT 7 TRANSLATION OF CATEGORICAL PROPOSITIONS INTO STANDARD FORM[*]

Structure

7.0 Objectives
7.1 Introduction: Translating Ordinary Language statements into standard form

7.2 Arranging standard from ingredients in order

7.3 Translating terms without nouns by replacing them with plural noun or pronoun

7.4 Non standard verbs to be replaced with standard copula

7.5 Translating Singular Propositions

7.6 Translating Categorical propositions whose Quantities are indicated by words other than the standard form quantifiers “All” “No” and “Some”

7.7 Translating Categorical Propositions which carry words which designate quantity more specifically than standard from propositions

7.8 Translating Categorical Propositions which do not carry any words at all to indicate quantity

7.9 Translating propositions which do not resemble standard form Categorical Propositions but can be translated into them

7.10 Translating Exceptive Propositions

7.11 Translating Exclusive Propositions

7.12 Translating Adverbs and Pronouns

7.13 Translating Conditional Statements

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7.14 Let Us Sum Up

7.15 Key Words

7.16 Further Readings and References

7.17 Answers to Check Your Progress

7.0 OBJECTIVES

Language is a dynamic and ever evolving phenomenon. Many arguments in our day to day life contain non standard form propositions. A standard form categorical syllogism is constituted of standard form propositions. In everyday interactions many syllogistic arguments contain nonstandard form propositions. In order to reduce an argument to standard form categorical syllogism it is required that their constituent propositions should be translated to standard form propositions. It is important to understand the meaning designated by a proposition to determine which of the categorical proposition is asserted or denied by it. To this end the list of methods enumerated to translate a proposition into standard form categorical proposition can never be exhaustive.

The objective of the present unit is,

- to explain comprehensive understanding of some methods used to translate a proposition into standard form categorical proposition.

7.1 INTRODUCTION: TRANSLATING ORDINARY LANGUAGE STATEMENTS INTO STANDARD FORM

In our everyday life we use language to communicate our thoughts and convey our emotions. In unit 1 we have discussed that this communication is possible through grammatical unit called ‘sentence.’ Moreover, in natural and social sciences we present our analysis through hypothetical, conjectural, speculative, perspectival opinions and beliefs. Broadly, sentences can be declarative, imperative, exclamatory, interrogative and of several other variety. However, in formal logic we are concerned with declarative statements i.e. propositions, since only they assert or deny a state of affairs. To begin with let us consider few examples of propositions, which are not in standard form:

"All students are not hard working"

"A cow is a vegetarian animal"

"Many dogs are pets"

"Roses are red"

"Lilies are fragrant"

The above mentioned propositions can be translated in standard form categorical propositions:

"Some students are not hard working people"

"All cows are vegetarian animals"

"Some dogs are pets"

"Some roses are red flowers"

"All lilies are fragrant flowers"

Many syllogisms, used for argumentations in our day to day life, are composed of nonstandard form propositions. In order to get standard form categorical syllogism we are required to translate the constituent propositions into standard form. We can form a categorical syllogism only with the help of standard form categorical propositions. There are various methods to reduce a non standard form sentence into standard form proposition. However, it is impossible to form an exhaustive list of set of rules for such translation as ordinary language is multifaceted and full of diversity. Although we can never develop a complete set of rules but we can describe a number of techniques that prove useful in dealing with certain kinds of non standard form of propositions. It is very significant that we have the capability to understand the given non standard form proposition so that the meaning of the given proposition should not be lost in this

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process. The present unit has primarily followed the methods for standard-translations suggested by Copi, Cohen and McMahon (2016) and Hurley and Watson (2019).

7.1 ARRANGING STANDARD FROM INGREDIENTS IN ORDER

In many propositions, although all the four components of standard form categorical proposition are present but it is observed that they are not arranged in the proper order. First, subject and predicate terms have to be identified and second all the constituents of a proposition have to be arranged in the standard schema:

Quantifier (subject term) copula (predicate term)

Bats are all blind.

Standard form translation: All bats are blind.

All is well that ends well.

Standard form translation: All things that end well are things that are well.

Gone are days of fun.

Standard form translation: All days of fun are days that are gone.

7.2 TRANSLATING TERMS WITHOUT NOUNS BY REPLACING THEM WITH PLURAL NOUN OR PRONOUN

In a categorical proposition, nouns or pronouns denote classes. For e.g. in the categorical proposition, ‘Some Dogs are pets’, ‘dogs’ being a common noun stands for class of dogs and ‘pets’ being a common noun stands for class of pets. If either subject or predicate is not noun, then it has to be translated into appropriate noun. However, in categorical propositions adjectives (and participles) connote attributes. In case a proposition has any term (subject or predicate), which is adjective then we will have to use a plural noun or pronoun in its place as only they denote the class. We should ensure that in a standard form categorical proposition there is one subject term (noun) and one predicate term (noun) and a copula to join them. In the examples taken below ‘green’ and ‘vegetarian’ designate attributes rather than a class and therefore these propositions have to be translated into standard form.

All cacti are green.

Standard form translation: All cacti are green plants.

All elephants are vegetarian.

Standard form translation: All elephants are vegetarian animals.

7.3 NON STANDARD VERBS TO BE REPLACED WITH STANDARD COPULA

In our day to day communication we often use statements which either incorporate other forms of the verb ‘to be’ or do not have any form of the verb ‘to be.’ We have already qualified in the first unit on categorical propositions that schematic representation of standard form categorical propositions follows ‘are’ and ‘are not’ as copula. The first variety of statements which have other forms of verb “to be” can be translated as follows:

Some geography books will be delivered shortly.

Standard form translation: Some geography books are books that would be delivered shortly.

Some people drink coffee.

Standard-from translation: Some people are coffee drinkers.

The second variety of statements, wherein there is no occurrence of the verb “to be”, can be translated as follows:

All tigers roar.

Standard form translation: All tigers are animals that roar.

All pigeons fly.

Standard form translation: All pigeons are birds that fly.

Some monkeys climb the tree.

Standard form translation: Some monkeys are animals that climb the tree.

Ojas plays football.

Standard form translation: Ojas is a football player.

7.4 TRANSLATING SINGULAR PROPOSITIONS

A singular proposition either asserts or denies that a particular individual or object belongs to a given class. They make assertion or denial about a specific person, thing, time or place. These propositions are generally converted into Universal propositions (A or E). Examples:

Einstein is a physicist.

This table is not an antique.

Unlike categorical propositions they do not affirm or deny the inclusion of one class in another. However, we can interpret a singular proposition as a proposition which deals with classes by interpreting them in the following manner:

"To every individual object there corresponds a unique **unit class** (one-membered class) whose only member is that object itself. Then, to assert that an object s belongs to a class P is logically equivalent to asserting that the unit class S containing just that object s is wholly included in the class P. And to assert that an object s does *not* belong to a class P is logically equivalent to asserting that the unit class S containing just that object s is wholly excluded from the class P." (Copi et al., 2016, p.186)

Moreover, Singular propositions are translated into universal propositions by using a "parameter" which is a tool used in a statement to alter the form without causing any change in meaning. Some parameters suggested are:

places identical to

people identical to

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things identical to

cases identical to

times identical to

Let us translate the following singular propositions with the help of parameters:

Einstein is a physicist.

Standard form translation: All people identical to Einstein are people who are physicists.

Explanation: Effectively what we are claiming here is that only one person can be identical to Einstein i.e. Einstein himself, the term “people identical to Einstein” denotes Einstein as this class has Einstein as its only member. (Hurley and Watson 2019, p.261)

This table is not an antique.

Standard form translation: No things identical to this table are things which are antique.

Geet went shopping.

Standard form translation: All people identical to Geet are people who went shopping.

Or

Geet is a person who went shopping.

However, at this juncture it is important to take note that there are some pertinent issues arising out of existential import of categorical propositions, namely, according to Boolean interpretation singular propositions have existential import but universal propositions do not have existential import, which we shall see in the upcoming units.

Check your Progress I

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

1. Translate the following statements to standard form propositions.

1. All roses are fragrant.
2. Skyscrapers are all tall buildings.
3. All dogs bark.
4. Some pigeons flew.
5. Reet plays tennis.
6. No neem leafs are sweet.
7. Some cars are not spacious.
8. There are no insurance policies which give good return claims.
9. Rohan is sitting at home.
10. Some cats climb the trees.
11. Not everyone subscribes to educational journals.
12. The moon is full tonight.
13. I hate wine.
14. All ducks swim.
15. Some birds fly during the winter.

7.5 TRANSLATING CATEGORICAL PROPOSITIONS WHOSE QUANTITIES ARE INDICATED BY WORDS OTHER THAN THE STANDARD FORM QUANTIFIERS "ALL" "NO" AND "SOME"

Many times statements begin with quantity designators other than the quantifiers or the quantity designators are not specified at all. The former cases require us to examine the statement in proper context and then rephrase the quantity designator. However, in the latter case the quantity designator is missing and we ought to provide it in terms of standard form.

Case 1

Statements beginning with ‘every’ ‘any’ ‘everything’ ‘anything’ (without any negation) are translated as A propositions in the following manner:

Every person has his day.

Standard form translation: All persons are beings who have their days.

Any day of the week is convenient.

Standard form translation: All days of the week are convenient days.

Everything in this room is expensive.

Standard form translation: All things in this room are expensive things.

Anything comes at a cost.

Standard form translation: All things are entities that come at a cost.

In parallel to these there are other examples of designators belonging to class of persons, like, whoever, everyone, anyone, whosoever, who and others. They are also translated as A propositions. For example:

Whoever votes, is a good citizen.

Standard form translation: All who vote are good citizens.

Anyone who goes to the party would be implicated.

Standard form translation: All who go to the party are those who are implicated.

Everyone who votes is above 18 years of age.

Standard form translation: All who vote are above 18 years of age.

Case 2

Indefinite articles ‘a’ or ‘an’, ‘the’ are also used to designate quantity. Although they do not clearly state quantity represented by them but when we examine the statement in its context,

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depending on the meaning, it is either translated as A or I proposition. Let us first consider examples of propositions which can be reasonably interpreted as universal propositions:

A dog is a mammal.

Standard form translation: All dogs are mammals.

An elephant is vegetarian.

Standard form translation: All elephants are vegetarian animals.

The snake is a reptile.

Standard form translation: All snakes are reptiles.

Let us now discuss different examples of propositions carrying ‘a’, ‘an’ and ‘the’ where the standard form translation is done to particular propositions.

A pigeon flew over the bridge.

Standard form translation: Some pigeons are birds which flew over the bridge.

A cat is rescued from the sea.

Standard form translation: Some cats are creatures that are rescued from the sea.

The frog in the left corridor is green.

Standard form translation: Some frogs in the left corridor are creatures that are green.

Judging from the context we can make out that article ‘a’ in the above two cases refers to a member and do not refer to all members of the class of pigeons, who flew over the bridge; or cats which are rescued from the sea. Similarly, article ‘the’ in the last case does not refer to all members of the class of frogs. While judging these propositions we have to be sensitive to the context.

We have translated the propositions beginning with ‘every’ and ‘any’ as A propositions in Case 1. Now let us see the examples of propositions beginning with ‘not every’ and ‘not any.’ In case of ‘not every’ the proposition is translated as particular negative and ‘not any’ is translated as universal negative. Examples:

Not every rose is red.

Standard form translation: Some roses are not red.

Not any student is full-time employed.

Standard form translation: No students are people who are full-time employed.

Words like ‘hardly’, ‘rarely’, ‘seldom’, ‘scarcely’, ‘little’, ‘not always’, ‘not everywhere’, ‘sometimes not’ are indicators of particular negative propositions. But the words like ‘never’, ‘nowhere’, ‘under no circumstances’ indicate universal negative propositions. (Copi et al., 2016, p.188)

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7.6 CATEGORICAL PROPOSITIONS WHICH CARRY WORDS WHICH DESIGNATE QUANTITY MORE SPECIFICALLY THAN STANDARD FROM PROPOSITIONS

Quantifiers such as, ‘one’, ‘two’, ‘three’, ‘many’, ‘few’, ‘a few’, ‘most’ or any other number mentioning quantity have to be translated to standard form. Proposition carrying ‘one’ should be translated same as a singular proposition**.** However, a proposition carrying all other numerical designators like, two, three, four, ten, fifty etc. to designate quantity should be translated as I propositions carrying ‘some’ as quantifier. ‘Many’, ‘several’, ‘sometimes, ‘usually’, ‘generally’ ‘occasionally’ ‘once’, ‘majority’, ‘most of them’, ‘once’ etc should also be translated as ‘some’.

However, special attention should be put to propositions using ‘a few’ and ‘few’ as designators. They cannot be translated into a single categorical proposition. Instead they are translated as a compound of I and O proposition. (Hurley and Watson, 2019, p. 264)

A few soldiers are heroes.

Standard form translation: Some soldiers are heroes and some soldiers are not heroes.

Few girls are passionate.

Standard form translation: Some girls are passionate and some girls are not passionate.

Most policemen are honest.

Standard form translation: Some policemen are honest.

7.7 CATEGORICAL PROPOSITIONS WHICH DO NOT CARRY ANY WORDS AT ALL TO INDICATE QUANTITY

At times there are propositions with no quantifier. In these cases what the sentence wants to express becomes quite ambiguous. In these cases the meaning of the sentences can be determined only by examining the context in which they occur. Let us take some examples:

Whales are mammals.

Students are absent.

Cars are parked in front of the house.

In the first example, “Whales are mammals”, it is very probable that it refers to all whales and should be translated as “All whales are mammals”. In the case of second statement, “Students are absent” it is clear that only some students are referred to and thus the standard form translation would be “Some students are beings who are absent”. Similarly, on a careful analysis of the context the third statement would also be translated as “Some cars are vehicles that are parked in front of the house”.

7.8 TRANSLATING PROPOSITIONS WHICH DO NOT RESEMBLE STANDARD FORM CATEGORICAL PROPOSITIONS AT ALL BUT THEY CAN BE TRANSLATED INTO THEM

In such cases, we begin by identifying the relevant context. Furthermore, we shall identify subject term and predicate term and then place the appropriate copula.

Not all citizens believe in God.

Standard form translation: Some citizens are not believers in God.

There are red roses.

Standard form translation: Some roses are red things.

Nothing is both hard and soft.

Standard form translation: No hard objects are soft objects.

There are good human beings.

Standard form translation: Some human beings are good human beings.

There are no red frogs.

Standard form translation: No frogs are red things.

Check your Progress II

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

1. Translate the following statements to standard form propositions.

1. Textbooks are useful.

2. Logic problems are difficult.

3. A tiger is a mammal.

4. A fish is not a mammal.

5. Children are human beings.

6. Not every citizen votes.

7. Not a single dog is a cat.

8. Many entertainers are actors.

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9. Few sailors are courageous.

10. Any student is eligible.

11. Every student is not resourceful.

12. Students are present.

13. There are honest politicians.

14. Flowers are beautiful.

15. Emeralds are green gems.

16. There are lions in the zoo.

17. A tiger is a mammal.

18. A fish is not a mammal.

19. A tiger roared.

20. Children are human beings.

21. Children live next door.

22. Children are naughty.

23. Not all players are physically fit.

24. Not every event is well organized.

25. There are no blue parrots.

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7.9 TRANSLATING EXCEPTIVE PROPOSITIONS

There are quasi-numerical terms, which require our careful attention like ‘almost all’, ‘all but’, ‘all except’ and others. Statements which use these expressions are called exceptive statements because they make exceptions in a general class. For example:

All except children are allowed to enter the cinema hall.

All but children are allowed to enter the cinema hall.
Children alone are not allowed to enter the cinema hall.

Translating these propositions is difficult as these propositions make two assertions. They are compound propositions and therefore we cannot choose them to represent one single standard form categorical proposition. To make a fair representation of their meaning each of these propositions should be translated into a conjunction of two standard form categorical propositions. All three propositions mentioned above have the same meaning and would be translated as “All non children are allowed to enter the cinema hall, and no children are allowed to enter the cinema hall.” Their logical form and standard translation can be represented as:

All except S is P

Standard form translation: All non S are P, and no S are P.

Another set of quasi numerical qualifiers include ‘almost all’, ‘not quite all’, ‘all but a few’ and ‘almost everyone.’ Propositions carrying these phrases would be treated in the similar manner as the set of exceptive propositions mentioned above. However, they will be written as conjunction of I and O proposition. Examples of these compound propositions:

Almost all employees were in the office.

Not quite all employees were at the office.

All but a few employees were at the office.

Almost everyone among employees were at the office.

Both propositions mentioned above have the same meaning. They assert that some employees were at the office and deny that all employees were at the office. Therefore they are translated as:

Some employees are persons who were at the office, and some employees are not persons who were at the office.

7.10 TRANSLATING EXCLUSIVE PROPOSITIONS

Categorical Propositions involving the words ‘only’, ‘none but’ ‘none except’ and ‘no…except’ are called exclusive propositions for the reason in these propositions the predicate term is exclusively applied to the subject named. Usually we confuse the positioning of subject and predicate terms in these propositions. Examples of such propositions are;

Only adults can enter cinema halls.

Standard form translation: All those who can enter the cinema hall are adults.

None but the citizens can vote.

Standard form translation: All those who can vote are citizens.

Propositions beginning with ‘only’ and ‘none but’ usually translate into A propositions. They follow the general rule of reversing the subject and predicate, and replace ‘only’ with ‘all’. Therefore the form of this translation would be:

Only S is P or None but S’s are P’s

Standard form translation: All P is S.

However, there can be some context in which ‘only’ and ‘none but’ are used to convey some different meaning. “Only S is P” and “None but S is P” can be taken to suggest either that “All S is P” or “Some S is P.” Therefore, we should take into account the context to determine meaning. However, in case we are not presented with any additional information the translations of these propositions should be done into A proposition.

7.11 TRANSLATING ADVERBS AND PRONOUNS

Let us consider the following example:

“The poor always you have with you.”

This proposition neither asserts that all the poor are with you, nor even that some poor are with you. If we notice the key word ‘always’ here this word means ‘at all times’ and when we use the word ‘times’ in both subject ad predicate terms we can translate the propositions as “All times are times when you have the poor with you” The word ‘times’ which appears in both the subject and the predicate terms is used as a ‘parameter’. We have shown the requirement and usage of a parameter in the previous sections of the unit.

When a proposition contains a temporal adverb, like, ‘when’, ‘whenever’, ‘anytime’, ‘always’ or ‘never’ it can be translated in terms of ‘times.’

Smith always wins at billiards.

Standard form translation: All times when Smith plays billiards are times when Smith wins at billiards.

Dogs bark whenever a car passes by.

Standard form translation: All times when a car passes by are times when the dogs bark.

Jones loses a sale whenever he is late.

Standard form translation: All times when Jones is late are times when Jones loses sales.

When a proposition contains a spatial adverb, like, ‘where’, ‘wherever’, ‘anywhere’, ‘everywhere’, ‘nowhere’ it might be translated in terms of ‘places.’ To translate some propositions into standard form, the words ‘places’ can be introduced as parameters.

Where there is no vision the people perish.

Standard form translation: All places where there is no vision are places where the people perish.

They go where they choose.

Standard form translation: All places they choose are places where they go.

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The alarm rings wherever the safe is touched.

Standard form translation: All places where the safe is touched are places where the alarms ring.

Propositions containing pronouns, like, ‘who’, ‘whoever’, ‘anyone’ may be translated in terms of ‘people.’

Whoever works hard will succeed.

Standard form translation: All people who work hard are people who will succeed.

Propositions containing pronouns, like, ‘what’, ‘whatever’, ‘anything’ may be translated in terms of ‘thing.’ All of these propositions are translatable into standard from categorical propositions. Consider the following examples:

Rohan does what he wants.

Standard form translation: All things Rohan wants to do are things Rohan does.

Moreover, we should notice the order of subject and predicate terms in the example. When translating such statements there is a possibility to confuse the subject term with the predicate term. The implicit rule to be followed: For W words (‘who’, ‘what’, ‘when’, ‘where’, ‘whoever’, ‘whatever’, ‘whenever’, ‘wherever’) the language following the “W” word goes into the subject term of the categorical proposition. (Hurley and Watson, 2019, p.263)

7.13 TRANSLATING CONDITIONAL STATEMENTS

In case of a conditional statement if the antecedent and consequent refers to the same class of people or things, then the statement is translated into universal categorical proposition. We have to note that the language which follows ‘if’ goes in the subject term of the categorical proposition, and the language following ‘only if’ goes in the predicate term. Let us consider few examples.

Sweet is tasty if it is made of pure ghee.

Standard form translation: All sweets made of pure ghee are tasty things.

If it is a whale, then it is a mammal.

Standard form translation: All whales are mammals.

If a dog is hungry, then it is dangerous.

Standard form translation: All hungry dogs are dangerous animals.

A meal is tasty only if it is made by mother.

Standard form translation: All tasty meals are meals made by mothers.

Moreover, a conditional statement which has a negated consequent but an affirmative antecedent is translated as E proposition. For example:

If it is a pigeon, then it is not an animal.

Standard form translation: No pigeons are animals.

A motorbike will run at a high speed only if it is not old.

Standard form translation: No motorbikes that run on high speed are old motorbikes.

Also, the word ‘unless’ means ‘if not.’ Statements which contain ‘unless’ are translated as categorical propositions which have negated subjects. For example:

Unless students misbehave they will be treated with respect.

Standard form translation: All students who do not misbehave are students who will be treated with respect.

Check your Progress III

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

1. Translate the following statements to standard form propositions.

1. If it’s a mouse, then it is a mammal.

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2. Jewelry is expensive if it is made of gold.

3. A car is a Camry only if it is a Toyota.

4. If it is not a turkey, then it is not a mammal.

5. Unless a boy misbehaves he will be treated decently.

6. Violence breeds violence.

7. All that glitters is not gold.

8. Children alone are not allowed to enter the cinema hall.

9. If it is a dog, then it is not a bird.

10. Anyone who jumps high sees the heights.

11. None but the brave deserve the fair.

12. Only policemen are indispensable.

13. All except children are allowed to do a job.

14. Almost all police men are at the station.

15. Accountants are the only one who will be hired.

7.14 LET US SUM UP

Propositions, which are not in standard form can be put into standard form following few tips.

- Translation must have a proper quantifier, subject term, copula and predicate term.
- Translate singular propositions by using a parameter.

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- Translate adverbs and pronouns by using parameters i.e. “persons”, “places” “things” and “times.”
- Language following “if”, “the only” and W words (“who” “what” “when”“where”, “whoever”, “whatever”, “whenever”, “wherever” goes in the subject term.
- Language following “only if” “only” “none but” “none except” and “no…except” goes in the predicate term.
- Propositions starting with ‘few’, ‘a few’, ‘almost all’, ‘all but a few’, ‘almost everyone’ must be translated as a compound of I and O propositions.
- Propositions of the form ‘All except S is P’ are translated as ‘All non S are P, and no S are P.’

Key word (to be eliminated)	**Translation Hint**
Whoever, wherever, always, anyone, never, etc.	Use “all” together with people, places, times
Few, several, many	Use “some”
If….. then	Use “all” or no”
Unless	Use “if not”
Only, none but, none except, no….except	Use “all”
The only	Use “all”
All but, all except, few	Two statements required
Not every, not all	Use “some….. are not”
There is, there are	Use “some”

Table Source: (Hurley and Watson, 2019, p. 267)

7.15 KEY WORDS

Exclusive Propositions: Propositions that assert that the predicate term applies exclusively only to the subject term.

Exceptive Proposition: Proposition that asserts that all members of some class, with the exception of the member of one of its subclasses, are members of some other class.

Parameter: An auxiliary symbol or phrase introduced to uniformly translate categorical propositions into standard form.

Singular Propositions: A proposition with a unit class, having only one member. Singular propositions assert or deny that the member has some specific attribute.

Standard form Categorical Propositions: Any categorical proposition of the form “All S is P” (universal affirmative), “No S is P” (universal negative), “Some S is P” (Particular Affirmative), “Some S is not P” (particular negative). They are known as A, E, I and O propositions respectively.

7.16 FURTHER READINGS AND REFERENCES

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7.17 ANSWERS TO CHECK YOUR PROGRESS

Check your Progress I

1. All roses are fragrant flowers
2. All skyscrapers are tall buildings
3. All dogs are animals that bark.

4. All pigeons are birds which fly.
5. Reet is a tennis player.
6. No neem leafs are sweet things.
7. Some cars are not spacious vehicles.
8. No insurance policies are policies which give good return claims.
9. All people identical to Rohan are people who are sitting at home or Rohan is a person who is sitting at home.
10. All cats are animals that climb the tree.
11. Some people are not subscribers of educational journals.
12. All things identical to moon are things that are full tonight.
13. All things identical to wine are things that I hate.
14. All ducks are swimmers.
15. Some birds are animals that fly during the winter.

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Check your Progress II

1. All textbooks are useful.

2. All logic problems are difficult problems.

3. All tigers are mammal.

4. No fish is a mammal.

5. All children are human beings.

6. Some citizens are not voters.

7. No dogs are cats.

8. Some entertainers are actors.

9. Some sailors are courageous people and some sailors are not courageous people.

10. All students are eligible people.

11. Some students are not resourceful.

12. Some students are persons who are present here.

13. Some politicians are honest beings.

14. All flowers are beautiful things.

15. All emeralds are green gems.

16. Some lions are animals in the zoo.

17. All tigers are mammals.

18. No fishes are mammals.

19. Some tigers are animals that roared.

20. All children are human beings.

21. Some children are people who live next door.

22. All children are naughty.

23. Some players are not physically fit.

24. Some events are not well organized.

25. No parrots are blue things.

Check your Progress III

1. All mice are mammals.

2. All pieces of jewelry made of gold are expensive things.

3. All Camrys are Toyotas.

4. No turkeys are mammals.

5. All boys who do not misbehave are boys who will be treated decently.

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6. All acts of violence are violence breeders.

7. Some things that glitter are not gold or Some glittery things are not gold.

8. All non Children are allowed to enter the cinema hall and No children are allowed to enter the cinema hall.

9. No dogs are birds.

10. All people who jump high are people who see the heights.

11. All those who deserve the fair are those who are brave.

12. All indispensible people are policemen.

13. All non children are allowed to do a job and No children are allowed to do a job.

14. Some policemen are at the station and some police men are not at the station.

15. All those who will be hired are accountants.

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UNIT 8 SQUARE OF OPPOSITION AND EXISTENTIAL IMPORT*

Structure

8.0 Objectives

8.1 Introduction

8.2 The Traditional Square of Opposition

8.3 Relations in Traditional Square of Opposition

8.4 Immediate Inferences: From Traditional Square of Opposition

8.5 Existential Import and the Interpretation of Categorical Propositions

8.6 Boolean Interpretation and the Square of Opposition

8.7 Let Us Sum Up

8.8 Key Words

8.9 Further Readings and References

8.10 Answers to check your Progress

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8.0 OBJECTIVES

The present unit aims to understand,

- the relations of opposition between the four standard form categorical propositions by the medium of traditional square of opposition as given by Aristotle. From the perspective of Aristotelian logic we have immediate inferences based on the relations in square of opposition. These are of four varieties, namely; Contradictories, Contraries,

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Subcontraries and Subalternation. Given the truth-value of a particular standard form categorical proposition we shall learn the derivation of truth-value of all the other three categorical propositions.

- the difference in interpretations arising in the relation between the propositions in the light of the interventions made by modern logician George Boole to resolve the existing inconsistencies. This analysis shall be undertaken along with an in depth analysis of existential import and various assumptions implied by it.

8.1 INTRODUCTION

In the preceding units we have defined categorical propositions and their kinds. In the present unit we will see that there are relations of opposition between these four standard form categorical propositions. Traditionally, the technical term used to denote this kind of differing is “opposition.” It is important to note that the central task of formal logic is to deal with analysis and evaluation of an argument. Validity/ Invalidity of an argument can be tested through inference. These inferences can be of two types; mediate inference and immediate inference. In the present unit we aim to understand how certain preliminary elementary forms of argument can be validated by immediate inference on the basis of relations in Traditional Square of Opposition. In case we are given the truth or falsehood of any one of the four standard form categorical propositions we can immediately infer the truth or falsehood of some or all the other three standard form propositions on the basis of the kind of relation of opposition between them. In the next unit we shall also study further immediate inferences.

8.2 THE TRADITIONAL SQUARE OF OPPOSITION

We have already observed in previous units that Aristotelian logic argued that the standard form categorical propositions, having same subject and predicate terms, might differ either in quality or quantity or both of them. The technical term with which these differences are designated is **opposition**. These different kinds of differences of truth relations that may hold between a pair of categorical statements are represented with the help of an important diagram called **Traditional Square of Opposition.** More specifically defined “opposition” is the logical relation that exists between two contradictories, contraries or other such relations displayed on

Traditional Square of Opposition. This term “opposition” need not denote any apparent disagreement between the propositions. The oppositions are correlated with some very important true relations. There are four possible ways in which the standard form categorical propositions are “opposed” with one another i.e. contradictories, contraries, subcontraries and subalterns and superalterns.

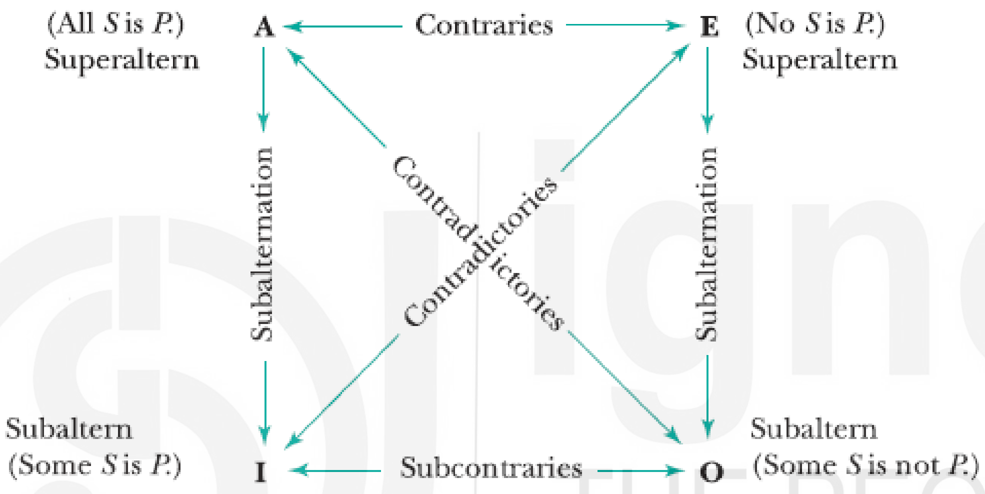

Diagram 1: Traditional Square of Opposition (Source: Copi et al., 2016, p. 114)

8.3 RELATIONS IN TRADITIONAL SQUARE OF OPPOSITION

8.3.1 Contradictories

Two propositions are contradictories when one is the denial or negation of the other proposition. Contradictories cannot both be true and cannot both be false. Two standard form categorical propositions that have the same subject and same predicate terms but differ from each other in both quality and quantity are contradictories. An A proposition, “All lawyers are accountants” and O proposition, “Some lawyers are not accountants” are contradictories. The reason is that they are opposed in both quantity (A refers to ‘all’ and O refers to ‘some’) and quality (one affirms, the other denies).We gather that out of the two exactly one is true and another is false. Similarly, the E proposition, “No lawyers are accountants” and I proposition, “Some lawyers are accountants” are contradictories as they are opposed to each other in both quantity and quality. Out of the two “A and I” and “E and O” one is true and the other is false. They can both be neither true nor false together.

“All S is P” is contradicted by “Some S is not P.”

“No S is P” is contradicted by “Some S is P.”

8.3.2 Contraries

Two propositions are said to be contraries if they cannot both be true together. In contrary propositions the truth of one entails the falsity of the other. However, both the propositions can be false. Let us take example of a one-day cricket match to be held between India and Australia. In the context of a match between two teams, the two propositions “India will win the upcoming game with Australia” and “Australia will win the upcoming game with India” are contraries. This implies that if one of the two statements is true then the other statement has to be false. However, if the result of the cricket match turned out to be a draw then both of these statements would be false. Therefore, these two propositions cannot both be true together however they can both be false. Unlike contradictories contraries can both be false.

Furthermore, let us figure out contraries among the four standard form categorical propositions. The traditional account of categorical propositions argues that the universal propositions (A and E) which have the same subject and same predicate terms but differ only in quality (one affirms and another denies) are contraries. Universal affirmative proposition, A “All poets are artists” and its corresponding E proposition “No poets are artists” cannot both be true but both of them can be false and therefore they are regarded as contraries. However, the modern logicians have identified a problem with this traditional Aristotelian interpretation, which shall be discussed in the second half of the chapter under the discussion on Existential Import.

Also, we shall qualify here that the A and E propositions are not taken as necessary propositions but assumed to be contingent i.e. they are neither necessarily true nor necessarily false. This assumption is important to our discussion because in case either A or E proposition is necessarily true i.e. in case either of them is a logical or mathematical truth, like, “All tautologies are true” or “No circles are rectangles” the claim that A propositions and E propositions are contraries cannot be correct. A necessarily true proposition cannot be false by definition and therefore it cannot have a contrary. We have already seen that by definition two propositions can only be contraries if they can both be false. We shall assume that according to the present interpretation the propositions are contingent so that we may correctly hold the claim that A and E propositions, which have the same subject and predicate terms are contraries (Copi et al., 2016, p.113).

8.3.3 Subcontraries

Two propositions are subcontraries when they cannot both be false, although they may both be true. The traditional account suggests that particular propositions (I and O), which have the same subject and predicate term but which differ from each other in quality (one affirms and another denies) are subcontraries. Particular affirmative proposition, ‘Some dogs are pets’ and particular negative proposition ‘Some dogs are not pets’ could both be true but they could not both be false and therefore are subcontraries.

Also, on the lines of the assumption made for contraries we shall qualify here that I and O propositions are assumed to be contingent i.e. they are neither necessarily true nor necessarily false. This assumption is important to our discussion because in case I or O proposition is necessarily false; like, “Some squares are triangles” or “Some triangles are not three-sided structures” the claim that I propositions and Opropositions are subcontraries cannot be correct. A necessarily false proposition cannot be true by definition and therefore it cannot have a subcontrary. We have already seen that by definition two propositions can only be subcontraries if they can both be true. We shall assume that according to the present interpretation the propositions are contingent so that we may correctly hold the claim that I and O propositions, which have the same subject and predicate terms, are subcontraries.

8.3.4 Subalteration

The relation of subalteration exists between two propositions when two categorical propositions, which have the same subject and predicate terms, agree in quality but differ in quantity. Since they agree in quality they are also called corresponding propositions i.e. A proposition “All dogs are mammals” has a corresponding proposition “Some dogs are mammals.” Similarly, “No whales are reptiles” has a corresponding proposition, “Some whales are not reptiles”. This

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relation holds between a universal statement and its corresponding particular statement. Subalteration is the relation of opposition between a universal proposition and its corresponding particular proposition. In these pair of corresponding propositions the universal propositions (A and E) are called superaltern and the particular propositions (I and O) are called subaltern respectively. Hence logically, the superaltern proposition implies the truth of subaltern proposition but not vice-versa.

For instance, from the universal affirmative proposition, “All spiders are eight-legged creatures” the particular affirmative subaltern proposition, “Some spiders are eight-legged creatures” follows. If A is true the corresponding E proposition is true. Similarly, from the universal negative proposition, “No spiders are eight-legged creatures” the particular negative proposition, “Some spiders are not eight-legged creatures” follows. If E is true the corresponding O proposition is true. However, the reverse does not hold i.e. if the particular proposition is true then the respective universal proposition is undetermined.

Moreover, in case I proposition is given as false then corresponding A proposition is also false and if O proposition is given as false then its corresponding E proposition is also false. However, the reverse does not hold i.e. if the universal proposition is false then the respective particular proposition is undetermined. We shall learn about the immediate inferences, which follow from the relations in the traditional square of opposition in the upcoming section.

Check your Progress I

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

A. State the contradictory of the following propositions:

1. All politicians are liars.
2. Some grapes are not sour.
3. All elephants are vegetarian.
4. Some soldiers are not officers.

B. State the contrary of the following propositions:

1. All women are authors.
2. No whales are fishes.
3. All surgeons are physicians.
4. No trees are machines.

C. State the subcontrary of the following propositions:

1. Some knives are sharp.
2. Some animals are not cats.
3. Some spiders are not eight-legged creatures.
4. Some books are thick.

D. State the superaltern of the following propositions:

1. Some games are inventions.
2. Some pilots are trained professionals.
3. Some books are thick.
4. Some boxes are heavy.

E. State the subaltern of the following propositions:

1. All masks are protection devices.
2. All bananas are fruits.
3. All phones are communication devices.
4. All bottles are containers.

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8.4 IMMEDIATE INFERENCES: FROM TRADITIONAL SQUARE OF OPPOSITION

On the basis of relations of oppositions presented in the traditional square of opposition we can draw several immediate inferences. To the present purpose we should start by differentiating between immediate and immediate inferences. In case of mediate inference we draw a conclusion from one or more premises. For example in categorical syllogisms wherein two premises imply conclusion, in such cases the conclusion is drawn from first premise through the mediation of the second. This inference shall be explored in the upcoming block. On the other hand when a conclusion is drawn from only one premise there is no need for mediation of the second premise and such inferences are called immediate inferences. We can draw many immediate inferences on the basis of Traditional Square of Opposition. If we are given the truth value of any of the four standard form categorical statements we can make immediate inference about the truth value of the other propositions. However, it is important to observe that in some cases the immediate inference will yield a definite conclusion and in some other cases it may yield to inconclusive answers.

In the previous unit we have understood the relations of opposition in Traditional Square of Opposition individually. Let us now see how these relations can be used to determine the truth-values of corresponding propositions. To find out truth-value of more than one proposition based on a given proposition, as a rule of thumb we can first use the relation of contradiction. Suppose the value of “All policemen are honest beings” is given as true. First, by contradiction relation we decide “Some policemen are not honest beings” is false. The truth-value of the rest of the statements can be determined by evoking other relations successively. Second, rule of thumb is that when one statement has logically undetermined truth-valuethen its contradictory statement also has logically undetermined truth-value. (Hurley and Watson, 2019, p. 241-242)

The truth-values can be determined through various routes. One such way is suggested below. However, we can seek help of other relations to reach the same results. Let us consider the following:

1. In case A is given as true: By relation of contradiction O must be false.

By relation of subalteration I must be true.

By relation of contrary E must be false.

2. In case E is given as true: By relation of contradiction I must be false.

By relation of subalteration O must be true.

By relation of contrary A must be false.

3. In case I is given as true: By relation of contradiction E must be false.

By the relation of subalteration from the truth of the particular proposition I nothing would follow about the truth-value of the universal proposition therefore A is undetermined; it may be true or it may be false.

By the relation of subcontrary both I and O can be true together and the truth of I does not stop O from being false, therefore the O is undetermined; nothing conclusive can be said it may be true or it may be false.

4. In case O is given as true: By relation of contradiction A must be false.

By the relation of subalteration from the truth of the particular proposition O nothing would follow about the truth value of the universal proposition therefore E is undetermined; it may be true or it may be false.

By the relation of subcontrary both I and O can be true together and the truth of O does not stop I from being false, therefore the I is undetermined; nothing conclusive can be said it may be true or it may be false.

5. In case A is given as false: By relation of contradiction O must be true.

By the relation of contrary both A and E can be false together. From the falsity of A it does not follow that E must be true nor it follows that E must be false. Therefore, E is undetermined.

By the relation of subaltern, the falsity of A neither implies that I must be false nor that it must be true. Therefore, I is undetermined.

6. In case E is given as false: By the relation of contradiction I must be true.

By the relation of contrary both A and E can be false together. From the falsity of E it neither follow that A must be true nor it follows that A must be false. Therefore A is undetermined.

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By the relation of subaltern, the falsity of E neither implies that O must be false nor that it must be true. Therefore, O is undetermined.

7. In case I is given as false: By the relation of contradiction E must be true.

   By the relation of subalternationA must be false.

   By the relation of subcontrary O must be true.

8. In case O is given as false: By the relation of contradiction A must be true.

   By the relation of subalternation E must be false.

   By the relation of subcontrary I must be true.

Check your Progress II

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

A. If A proposition “All policemen are honest” is true what can be inferred about the truth or falsity of the following propositions:

1. No policemen are honest.

2. Some policemen are honest.

3. Some policemen are not honest.

B. If E proposition “No policemen are honest” is true what can be inferred about the truth or falsity of the following propositions:

1. All policemen are honest.

2. Some policemen are honest.

3. Some policemen are not honest.

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C. If I proposition “Some policemen are honest” is true what can be inferred about the truth or falsity of the following propositions:

1. All policemen are honest.
2. No policemen are honest.
3. Some policemen are not honest.

D. If O proposition “Some policemen are not honest” is true what can be inferred about the truth or falsity of the following propositions:

1. All policemen are honest.
2. No policemen are honest.
3. Some policemen are honest.

E. If A proposition “All policemen are honest” is false what can be inferred about the truth or falsity of the following propositions:

1. No policemen are honest.
2. Some policemen are honest.
3. Some policemen are not honest.

F. If E proposition “No policemen are honest” is false what can be inferred about the truth or falsity of the following propositions:

1. All policemen are honest.

2. Some policemen are honest.

3. Some policemen are not honest.

G. If I proposition “Some policemen are honest” is false what can be inferred about the truth or falsity of the following propositions:

1. All policemen are honest.

2. No policemen are honest.

3. Some policemen are not honest.

H. If O proposition “Some policemen are not honest” is false what can be inferred about the truth or falsity of the following propositions:

1. All policemen are honest.

2. No policemen are honest.

3. Some policemen are honest.

I. For each of the following questions, given the truth-value of one of the four types of categorical propositions, determine the truth-values of the other three categorical propositions. Use your understanding from Traditional Square of Opposition to determine the correct answer.

1. If A proposition is T then what can you conclude about E proposition.
2. If A proposition is T then what can you conclude about I proposition.
3. If A proposition is F then what can you conclude about O proposition.
4. If A proposition is F then what can you conclude about I proposition.
5. If E proposition is F then what can you conclude about I proposition.
6. If E proposition is F then what can you conclude about O proposition.

7. If E proposition is T then what can you conclude about A proposition.
8. If E proposition is T then what can you conclude about O proposition.
9. If O proposition is T then what can you conclude about E proposition.
10. If O proposition is T then what can you conclude about A proposition.
11. If O proposition is F then what can you conclude about I proposition.
12. If O proposition is F then what can you conclude about E proposition.
13. If I proposition is T then what can you conclude about A proposition.
14. If I proposition is T then what can you conclude about O proposition.
15. If I proposition is F then what can you conclude about E proposition.
16. If I proposition is F then what can you conclude about A proposition.

8.5 EXISTENTIAL IMPORT

Existential import is that attribute of a categorical proposition, which asserts the existence of objects. A proposition having existential import asserts the existence of objects i.e. the class designated by the subject term of the categorical proposition is assumed to have at least one member. In other words the categorical propositions have existential import when the class designated by the subject term is non-empty. The classical logicians of Aristotelian tradition argue that all four categorical propositions A, E, I, and O have existential import. However, the modern logicians agree that I and O have existential import but they disagree with Classical logicians and do not attribute existential import to A and E propositions. Along with other references mentioned in the chapter I have mainly referred to *Introduction to Logic* (Copi et al., 2016) for the present and following sections.

The issue at hand is to be decided with utmost care. A student of logic is concerned with the correctness/incorrectness of reasoning. It is assumed that evaluation of validity/invalidity of an argument and correctness of reasoning in many arguments depends on the fact that whether the propositions, which constitute that argument, have existential import or not i.e. they have members or not. We have already seen that categorical propositions are preliminary units or building blocks of arguments. Along with translating ordinary language propositions in standard form and symbolizing the A, E, I and O propositions, we shall also guard ourselves against any incorrect inferences by establishing what is asserted or denied by the proposition about class membership. It is important to understand the resolution of the controversy of existential import in order to explore how we can develop a coherent analysis of a categorical syllogism.

Modern logicians argue that particular propositions I and O always have existential import. Let us understand the reasons they give for this claim by the help of examples:

Some animals are reptiles.

Some dogs are not pets.

The first proposition, “Some animals are reptiles” asserts that there exists at least one animal which is a reptile. Also the second proposition, “Some dogs are not pets” asserts the existence of some dogs or at least one dog and additionally asserts that those dogs or that one dog is not a pet. In both I and O propositions the classes designated by the subject terms are not empty. If these propositions are true then both the class of “animals” as well as the class of “dogs” each has at least one member. We shall see the interpretation of particular propositions in more detailed manner in the coming section.

However, in the history of logic, whether the universal propositions, A and E, have existential import or not is a matter on which there is no consensus. To understand the matter at hand we should begin by asking the primary question, when can we reasonably conclude that something exists? The modern logicians would answer that until we have definite evidence it is not logically justified to assume existential import. Let us understand why the traditional logicians believe that universal propositions have existential import while modern logicians deny it. For example:

A: All unicorns are horned creatures.

E: No inhabitants of moon are honest beings.

According to traditional logicians these two statements A and E have existential import i.e. the subject terms “unicorns” and “inhabitants of moon” refer to non-empty classes. But we know that there are no “unicorns” or “inhabitants of moon.”“Unicorn” is a fictional character and “inhabitant of moon” might be a possibility in distant future but it definitely is an empty class at present. Now the problem arises when we consider the consequences of the assumption of traditional logicians that A and E propositions mentioned above have existential import i.e. do have members. According to Traditional Square of Opposition two propositions are contradictories when only one of the propositions in the pair can be false at a time. But if we consider that the contradictory propositions, “All inhabitants of moon are honest beings” and “Some inhabitants of moon are not honest beings” have existential import i.e. there are “inhabitants of moon” then both these propositions would be false if it is the case that moon has no inhabitants. We know through our factual knowledge that the subject class i.e. the class of “inhabitants of moon” is empty therefore both the propositions are false. The problem arises that if we assume that universal propositions (in this case proposition A) have existential import then the relation of contradiction does not seem to hold in the Traditional Square of Opposition. If we assume existential import in the cases discussed above then both the propositions cannot be contradictories because in the contradiction relation only one of them can be false at a time.

We wonder how to explain the incompatible relations. The issue here is that we have a choice between preserving the relation of contradiction in Traditional Square of Opposition and preserving the traditional assumption of existential import and only one of them can hold in the existing situation. Another issue is that Traditional Square of Opposition claims that I follows validly from A through relation of subalteration. Similarly, O follows validly from E through the relation of subalteration. But for I and O to follow validly from A and E propositions A and E should have existential import. Otherwise how can a proposition without existential import validly imply a proposition, which has existential import from proposition, which does not have existential import. As from a claim to non-existence it would be inconsistent to move towards a claim to existence.

In order to rescue the relations in traditional square of opposition the concept of existential presupposition is introduced. We begin with a presupposition that all categorical propositions A, E, I and O refer to classes which have members and they are not empty. We make a blanket presupposition that all classes designated by our terms do have members i.e. we presuppose that the classes to which categorical propositions refer have members and they do not refer to empty classes. In this way all the relationships in Traditional Square Opposition are rescued.

- A and E remain contraries.
- I and O remain subcontraries.
- Subaltern I follows from superaltern A.
- Subaltern O follows from superaltern E.
- A and O remain contradictories.
- E and I remain contradictories.

The existential import is a presupposition, which is sufficient as well as necessary to rescue Aristotelian logic as well as traditional square of opposition. Even the ordinary use of modern languages, like, English makes this presupposition. For example, on being told, “All the masks on the table are made of cotton” we assume that the subject class is non-empty. We assume the existence of masks. However, if on observation we were to find out that there are no masks on the table then we would assume that the speaker has made a mistake i.e. in this case the existential presupposition about existence of masks was false. We would not argue that the claim is false or true. This shows that in general usage of language we do understand and accept the existential presupposition of propositions (Copi et al., 2016, p. 128-129).

Although we preserve the traditional relations in the square of opposition but this blanket assumption has other limitations. The blanket presupposition imposes heavy intellectual penalties. If we presuppose that the class designated by all categorical propositions has members then the question confronts us- Will we ever be able to formulate the proposition that denies the existence or denies that the class has members? It also curtails our power of expressing categorical propositions, which express empty classes. Furthermore, there are times when we utter propositions with the intention of using the term to designate empty classes. For example, when the Traffic Department makes a rule, “All those who break the traffic rules their driving license would be cancelled” they do not presuppose that “the class of those who break the traffic rules” should have members. Instead the intention of traffic department would be that the class would become and remain empty. Also, this statement would be taken as true even if no one were ever prosecuted. The word "all" in this statement might be assumed to refer to an empty class. Mostly, we make rules and laws intending the subject class to be empty.

Also, another limitation is that we would never be able to make statements about empty classes like, "All yellow zebras are creatures that have giraffe necks" and many others, which are statements made about hypothetical classes with possible characterizations in fictional works.

At times, we reason about theoretical entities without making any commitment about their existence, especially in case of scientific principles. Most of the times in science we refer to concepts like, points, lines, bodies at rest, bodies not acted upon, plane, frictionless, ideal gases, planets and several other conjectural entities. However, the scientists or mathematicians assume them hypothetically and do not necessarily want to commit that these entities actually physically exist.

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4.6 BOOLEAN INTERPRETATION AND THE SQUARE OF OPPOSITION

For the above mentioned and other such reasons, George Boole and other modern logicians suggested that it is better to restrict existential import only to I and O propositions.[*] According to Boolean interpretation we make following claims:

- A and E do not have existential import.
- Only I and O statements have existential import.

On Boolean interpretation we commit an existential fallacy if we assume existence (a class has members) where we do not have clear evidence to claim existence. If an argument relies on this mistake it commits the fallacy of existential assumption or existential fallacy. Therefore, we cannot assume the existence of individuals in the subject term of universal propositions.

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[*] Patrick J. Hurley clarifies that it was not George Boole but John Venn who eliminated existential import from universal propositions. In the book *Symbolic Logic* John Venn insisted that universal propositions should be interpreted as having no existential import. This modification by Venn is what is accepted as official Boolean position known to us. For more details on this please refer (Hurley, 2019, p. 226-227).

The modern interpretation argues that a conditional statement, which makes no assertion concerning the existence of members in a class, designates universal propositions. On Boolean interpretation there is no assumption that in the propositions mentioned below the class of either “men” or “unicorn” or “mangoes” or “dogs” is a non-empty class. According to Boolean interpretation the universal statement A is written as the conditional of the following type:

For any x, if x is S then x is P.

Let us take examples of universal proposition A and E with their modern interpretation:

“All men are mammals” would mean “for any x, if x is a man then x is a mammal”

“All unicorns are mammals” would mean “for any x, if x is a unicorn then x is a mammal”

“No mangoes are yellow objects” would mean “for any x, if x is a mango then x is not yellow object”

“No dogs are cats” would mean “for any x, if x is a dog then x is not a cat”

We see that none of these conditional statements make any assertion concerning the existence of members of a class. However, according to Boolean interpretation unlike “all” in universal propositions, the word “some” in an I proposition makes the claim that there is a membership in the subject class. “Some” is interpreted to mean “at least one.” Therefore if particular propositions are true then subject class is not empty because particular propositions are analyzed as conjunction with an existential claim. For example,

“Some roses are beautiful” would mean “There is at least one x such that x is a rose and x is beautiful”

However, we should note that in the Boolean interpretation there is no claim to membership in subject class of universal propositions. If “unicorn” is the subject and there are no members in the subject class (subject being empty) then both the propositions “No S is P” as well as “All S is P” can be true. Also, If there are no unicorns, then I proposition, “Some unicorns are horned creatures” and O proposition, “Some unicorns are not horned creatures” are both false.

What we witness is that the Boolean interpretation results in an important shift in the relations of opposition in Traditional Square of Opposition.

1. Since A and E do not have existential import and I and O do have existential import therefore the relation of subalternation does not hold in modern interpretation. It will be an existential fallacy to infer a statement, which has existential import from premises, which do not have existential import. From the truth of universal propositions we cannot follow the truth of particular propositions.
2. The relation of contraries does not hold for corresponding A and E propositions. If there are no "inhabitants of moon" then both the propositions "All inhabitants of moon are honest beings" and "No inhabitants of moon are honest beings" can be true. We have seen above that both A and E would be written as conditional propositions "if thereis an inhabitant of moon then it is an honest being" and "if there is an inhabitant of moon then it is not an honest being" and conditional can both be true together if there is no member in the subject class.
3. Similarly the relation of subcontraries does not hold for corresponding I and O propositions. In case the subject class turns out to be empty then both the corresponding I and O propositions can be false together. Since corresponding I and O propositions have existential import in case there are no "inhabitants of moon" it would be false to assert both "Some inhabitants of moon are honest beings" as well as "Some inhabitants of moon are not honest beings."By traditional definition subcontraries cannot be false together although they may be true. Since by the above analysis we gather that they can be false together therefore the relation of subcontraries does not hold.
4. However, like the traditional square even in modern interpretation universal propositions A and E are the contradictories of the particular propositions O and I. We just noted that if we begin with a presupposition of existence in the case of contradictory propositions A and O and then the subject class turns out to be empty then both the propositions would become false. Thus relation of contradiction would not hold. However, if we accept the modern interpretation then the relation of contradiction holds between A and O as well as E and I(Copi et al., 2016, p.130-131).

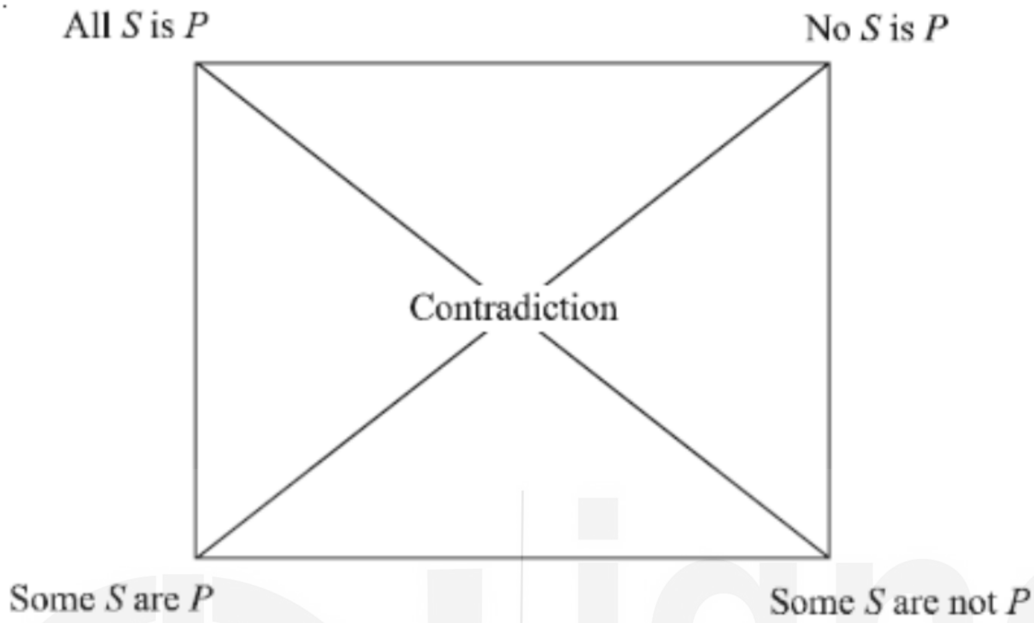

Diagram 2: The Square of Opposition after Boolean Interpretation (Source: Chakraborty, 2006, p. 255)

Since the blanket modern logicians the traditional square of opposition is only left with the relation of contradiction reject existential presupposition. According to Boolean interpretation the relations along the side of the square are undone and only the diagonal relation i.e. contradictory remains. Also, the Boolean interpretation has an impact on further immediate inferences performed by limitation. Since the subalternation relation is not a valid relation in this interpretation therefore conversion by limitation for A proposition is invalid. Also, for the same reason contraposition by limitation for E proposition is invalid. We shall elaborate on this matter in the next unit.

Although Boolean interpretation is not making an assumption of existence in case of universal propositions yet there is a scope to use universal proposition whenever we intend to assert existence. In order to do this we require asserting two propositions i.e. universal as well as particular. The universal proposition, “All human beings on earth are mortal” has no existential import and it makes a limited claim, “if there is a human being on earth then he/she is mortal.” In case we claim this proposition and wish to refer to existing human beings then it would have to be asserted as a conjunction of the two. This implies that we would have to assert another particular proposition alongside which intends to assert existence of human beings on earth. Thus we assert, “Ojas is a human being on earth.” Therefore the resultant proposition is a conjunction, “All human beings on earth are mortal” and “Ojas is a human being on earth.” It would take the form, “For any x, if x is a human being then x is mortal, and there is at least an x and x is a human being.”This proposition adds the existential force and refers to actual human beings. Therefore in a universal statement whenever we intend to assert the existence of members of the subject term we will have to add an existential statement separately. According to modern logicians, the impact of Boolean interpretation would hold that only relation of contradiction is valid in square of opposition.

Furthermore, unlike the case of universal propositions, the particular propositions I and O are always assumed to have existential import under both modern as well as traditional interpretations. The issue of existential import pertains only to universal propositions. On the traditional interpretation of universal propositions we need to determine whether or not the subject class denotes things, which actually exist in the world. The question regarding existence is dependent on truth-value. Therefore under traditional interpretation truth-value of a proposition or propositions in an argument play a role in determining validity/invalidity of an argument. However, according to modern interpretation validity/invalidity of an argument is a purely logical concept. (Baronett, 2013, p. 193)

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8.7 LET US SUM UP

Immediate inferences based on Traditional Square of Opposition:

A is given as true: E is false; I is true; O is false.

E is given as true: A is false; I is false; O is true.

I is given as true: E is false; A and O are undetermined.

O is given as true: A is false; E and I are undetermined.

A is given as false: O is true; E and I are undetermined.

E is given as false: I is true; A and O are undetermined.

I is given as false: A is false; E is true; O is true.

O is given as false: A is true; E is false; I is true.

8.8 KEY WORDS

Contradictories: When two propositions are related in such a manner that one is the denial or negation of another. A and E are the contradictories of I and O respectively.

Contraries: When two propositions are related in such a manner that although they both may be false but they cannot both be true.

Existential Fallacy: Any mistake in reasoning that arises from assuming illegitimately that some class has members.

Existential Import: An attribute of those propositions that normally assert the existence of objects of some specified kind. Particular propositionsI and O always have existential import. However, Aristotelian and Boolean interpretations of propositions differ on whether universal propositions have existential import or not.

Opposition: The logical relations, displayed on the square of opposition, which exist between any two propositions that differ in quality, quantity or other respects. They are relations between two contradictories, contraries, subcontraries and others.

Square of Opposition: A square shaped diagram, which exhibits logical relations between four types of categorical propositions (A, E, I and O) situated in the four corners.

Subalternation: The relation on square of opposition between auniversal proposition and its corresponding I or O proposition where the particular proposition is called “subaltern” and the universal proposition is called “superaltern.

Subcontraries: When two propositions are related in such a manner that although they may both be true but they cannot both be false.

8.9 FURTHER READINGS AND REFERENCES

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8.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress I

A. Contradictory:

1. Some politicians are not liars. Since the given proposition is A its contradictory is an O proposition.
2. All grapes are sour. Since the given proposition is O its contradictory is an A proposition.
3. Some elephants are not vegetarian. Since the given proposition is an A proposition its contradictory is an A proposition.
4. All soldiers are officers. Since the given proposition is an O proposition its contradictory is an A proposition.

B. Contrary:

1. No women are authors. Since the given proposition is an A proposition, its contrary is an E proposition.

2. All whales are fishes. Since the given proposition is an E proposition its contrary is an A proposition.
3. No surgeons are physicians. Since the given proposition is an A proposition its contrary is an E proposition.
4. All trees are machines. Since the given proposition is an E proposition its contrary is an A proposition.

C. Subcontrary:
1. Some knives are not sharp. Since the given proposition is an I proposition its subcontrary is an O proposition.
2. Some animals are cats. Since the given proposition is an O proposition its subcontrary is an I proposition.
3. Some spiders are eight-legged creatures. Since the given proposition is an O proposition its subcontrary is an I proposition.
4. Some books are not thick. Since the given proposition is an I proposition its subcontrary is an O proposition.

D. Superaltern:
1. All games are inventions. Since the given proposition is an I proposition its superaltern is an A proposition.
2. All pilots are trained professionals. Since the given proposition is an I proposition its superaltern is an A proposition.
3. All books are thick. Since the given proposition is an I proposition its superaltern is an A proposition.
4. All boxes are heavy. Since the given proposition is an I proposition its superaltern is an A proposition.

E. Subaltern:

1. Some masks are protection devices. Since the given proposition is an A proposition its subaltern is an I proposition.
2. Some bananas are fruits. Since the given proposition is an A proposition its subaltern is an I proposition.
3. Some phones are communication devices. Since the given proposition is an A proposition its subaltern is an I proposition.
4. Some bottles are containers. Since the given proposition is an A proposition its subaltern is an I proposition.

Check Your Progress II

A.

1. E is false (by contrary)
2. I is true (by subalternation)
3. O is false (by contradiction)

B.

1. A is false (by contrary)
2. I is false (by contradiction)
3. O is true (by subalternation)

C.

1. A is undetermined
2. E is false (by contradiction)
3. O is undetermined

D.

1. A is false (by contradiction)
2. E is undetermined
3. I is undetermined

E.

1. E is undetermined
2. I is undetermined
3. O is true (by contradiction)

F.

1. A is undetermined
2. I is true (by contradiction)
3. O is undetermined

G.

1. A is false (by subalternation)
2. E is true (by contradiction)
3. O is true (by subcontrary)

H.

1. A is true (by contradiction)
2. E is false (by subalternation)
3. I is true (by subcontrary)

I.

1. False
2. True
3. True
4. Undetermined
5. True
6. Undetermined
7. False
8. True
9. Undetermined

10. False
11. True
12. False
13. Undetermined
14. Undetermined
15. True
16. False

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UNIT 9 IMMEDIATE INFERENCES[*]

Structure

9.0 Objectives

9.1 Introduction

9.2 Conversion

9.3 Concept of Class and Complementary Class

9.4 Obversion

9.5 Contraposition

9.6 Successive Immediate Inferences

9.7 Let Us Sum Up

9.8 Key Words

9.9 References

9.10 Answers to check your Progress

9.0 OBJECTIVES

In the previous unit we have already understood the concept of immediate inference. Conversion, Obversion and Contraposition are further immediate inferences. In Aristotelian logic, apart from the relations of square of opposition which can serve as the basis for immediate inferences about the truth value of categorical statements, which have the same subject and predicate terms, there are three other kinds of further immediate inferences:

1. Conversion
2. Obversion

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3. Contraposition

The objective of the present unit is,

- to study immediate inferences of Conversion, Obversion and Contraposition for all the four standard form categorical propositions.
- to learn advanced exercises based on an application of combination of relations from traditional square of opposition as well as further immediate inferences under the section "Successive Immediate Inferences."

9.1 INTRODUCTION

Different interpretations of categorical propositions in the light of presumption and denial of existential import by traditional and modern logicians respectively impacts the validity/invalidity of their conversion/obversion/contraposition. We would develop this understanding in the light of the discussion on existential import and Boolean interpretation in the previous unit. However, it is significant to note that these further immediate inferences are not associated directly with the square of opposition.

9.2 CONVERSION

Conversion is the immediate inference which proceeds by change of position of the terms i.e. interchanging the subject and the predicate terms of a proposition. A standard form categorical proposition is called converse of another proposition when we derive it simply by interchanging the subject and predicate of that proposition. The proposition from which the converse is derived is called convertend. Structure of conversion can be put as follows:

Premise: S is P

Conclusion by conversion: P is S

No change in quality or quantity of the premise is allowed in case of conversion only the change of position of the terms is allowed.

I proposition: Conversion can be safely done for I propositions. Conversion preserves the truth value when it is applied to and gives a reliable valid inference for I statements. For example the converse of the proposition, “Some authors are rich people” is “Some rich people are authors” which is logically equivalent to it. We see that by means of conversion either of them can be inferred validly from the other. Two propositions are logically equivalent propositions.

E proposition: Like the case of I propositions, conversion is valid for E proposition. For example the converse of the proposition, “No authors are rich people” is “No rich people are authors” which is logically equivalent to it. In this case “No authors are rich people” is convertend. We observe that when we convert E or I statement it gives us a new statement that always has the same meaning.

O proposition: The conversion of O propositions is not valid. For example, “Some animals are not pets” is true but its converse the proposition “Some pets are not animals” is false. They are not logically equivalent statements.

A proposition: In case of A propositions we face a special case in view. The converse of A propositions does not follow from its convertend. From “All elephants are mammals” we cannot infer “All mammals are elephants” as clearly they are not logically equivalent and do not carry the same meaning i.e. “All elephants are mammals” is true but from it we cannot infer that “All mammals are elephants” would also be true. Both propositions have unrelated truth value. Thus, conversion is not a reliable process for A statements and does not give rise to logically equivalent statements.

However, traditional Aristotelian logic holds that for A propositions conversion is a valid process. Moreover, for the reasons cited above it suggests that in case of A propositions we perform **conversion by limitation**. This inference is called “conversion by limitation”. We have seen in the previous unit that in Traditional Square of Opposition, we can validly infer from A proposition, “All elephants are mammals” its subaltern I proposition, “Some elephants are mammals.”A proposition says something about ‘all’ members of the subject class the I proposition makes a more limited claim only about ‘some’ members of that class. Therefore, one could infer “Some S is P” from “All S is P.” And once we have an I proposition, “Some S is P” we know that conversion of I proposition is valid i.e. from “Some elephants are mammals” we can easily convert “Some mammals are elephants.” Hence according to traditional logic although conversion for A propositions is valid by limitation but the converse and convertend are not logically equivalent.

In **conversion by limitation** conversion is performed after putting a limitation on the quantity of the given statement. We follow a combination of subalternation and conversion and successfully convert “All S is P” to “Some P is S.” The procedure we follow for conversion of A proposition is as follows:

For a given A proposition, “All elephants are mammals”

Step 1: “Some elephants are mammals” (by subalternation changing the quantity)

Step 2: “Some mammals are elephants” (by conversion interchanging the subject and predicate terms)

It is important to note that according to the modern logic Conversion by limitation is not valid.

S no.	Categorical Propositions	Convertend	Converse
1.	A	All S is P	Some P is S (by limitation)
2.	E	No S is P	No P is S
3.	I	Some S is P	Some P is S
4.	O	Some S is not P	(Conversion not possible)

Table 1: Conversion

9.3 CONCEPT OF CLASS AND COMPLEMENTARY CLASS

As explained in previous units, concept of class can be understood as the collection of all objects that have a certain common attribute, which is the “class-defining characteristic” of all objects belonging to that class. For example the class defining character of all animals would be the characteristic of being animal. The class-defining characteristic is the attribute of being animal.

Every class has a complementary class associated with it. Complementary class of a given class entails the collection of all things that do not belong to the given class. The complement of the class of all animals contains everything else except animals. Complement class of all animals would contain all things like, trains, trees, mountains, rivers and others but cannot contain tigers or elephants as they are animals. Complement of class of all animals is designated as the "class of all non-animals." Usually we attach a prefix "non" to the term. The complement of the term "cat" is "non-cat", the complement of the term "chair" is "non-chair" and so on. The circle represents the class of cats and everything outside the circle represents the class of non-cats.

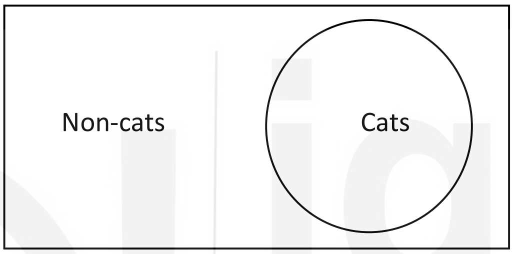

Figure 1: Venn diagram for representation of relationship between class and complementary class

Furthermore, we should note that the complement of the term "animal" is "non-animal" but the complement of the term "non-animal" is not written as "non-non-animal" but simply as "animal". Also, we have to be cautious and should not mistake contrary terms for complementary terms. The contrary of the term "coward" is "hero" but its complementary is "non-coward." The reason is that not everyone is either coward or hero but absolutely everyone is either coward or non-coward.

9.4 OBVERSION

The process of obversion requires two steps:

Step 1: First, we reverse the quality of the given statement. That is, if it is affirmative then we should change it into negative and if it is negative then we should change it into affirmative.

Step 2: Second, we replace the predicate term by its complementary term.

It is important to note that both the subject term and the quantity of the proposition to be obverted remain unchanged. Neither the subject nor the predicate terms are interchanged nor is universal proposition changed into particular or vice-versa.

It is advisable for the beginners to practice obversion in two steps. However, once we have practiced and are well versed with the process we can combine the steps and do obversion in one single step.

A proposition: "All dogs are animals"

Step 1: No dogs are animals. (Changing the quality)

Step 2: No dogs are non-animals. (Replacing the predicate term by complementary term)

E proposition: "No dogs are animals"

Step 1: All dogs are animals. (Changing the quality)

Step 2: All dogs are non-animals. (Replacing the predicate term by complementary term)

I proposition: "Some dogs are animals"

Step 1: Some dogs are not animals. (Changing the quality)

Step 2: Some dogs are not non-animals. (Replacing the predicate term by complementary term)

O proposition: "Some dogs are not animals"

Step 1: Some dogs are animals. (Changing the quality)

Step 2: Some dogs are non-animals. (Replacing the predicate term by complementary term)

The obverse of A proposition is an A proposition; the obverse of an E proposition is an E proposition; the obverse of an I proposition is an I proposition and the obverse of an O proposition is an O proposition. The proposition which serves as premiss is called obvertend and the conclusion is called obverse. Furthermore, obversion is always a valid form of immediate inference when it is applied to any standard form categorical proposition i.e. A, E, I and O. Obversion of all four standard form categorical propositions gives rise to logically equivalent propositions.

S no.	Categorical Propositions	Obvertend	Obverse
1.	A	All S is P	No S is non P
2.	E	No S is P	All S is non P
3.	I	Some S is P	Some S is not non P
4.	O	Some S is not P	Some S is non P

Table 2: Obversion

9.5 CONTRAPOSITION

Contraposition as an immediate inference requires the first two processes i.e. conversion and obversion. To form the contrapositive of a given proposition we follow two steps:

Step 1: We convert the statement by reversing the subject and the predicate terms.

Step 2: We replace both terms by their complementary terms.

In other words we can say that the contrapositive of a given proposition is formed by replacing its subject term with the complement of its predicate term and replacing its predicate term with the complement of its subject term.

A proposition: The contraposition of the A proposition, “All cats are pets” is the A proposition, “All non-pets are non-cats.” On a closer reflection they are logically equivalent to one another. When we apply contraposition of A propositions we form a valid form of immediate inference as it gives rise to logically equivalent propositions. Also, there is another way through which we can get contraposition; by first obverting then converting and then again obverting it again. Given “All cats are pets” we require performing three steps to give a contraposition. These steps are laid out as follows:

Step 1: Obvert to “No cats are non-pets”

Step 2: Convert to “No non-pets are cats”

Step 3: Obvert to “All non-pets are non-cats”

O proposition: On the lines of A proposition the contraposition of an O proposition is a valid immediate inference as O proposition and its corresponding contrapositive O proposition are logically equivalent to each other. For example the contraposition of “Some cats are not pets” is “Some non-pets are not non-cats” as it introduces no new information. Given “Some cats are not pets” we take the following steps:

Step 1: Obvert to “Some cats are not non-pets”

Step 2: Convert to “Some non-pets are cats”

Step 3: Obvert to “Some non-pets are not non-cats”

I proposition: For I propositions contraposition is not a valid form of inference as the contrapositive of I proposition is not logically equivalent to it. For example the contrapositive of “Some cats are pets” is “Some non-pets are non-cats”, which does not have the same truth value and meaning as the given proposition. If “Some cats are pets” is true then “Some non-pets are non-cats” is false. The reason for contraposition being invalid is that when we obvert I proposition we get an O proposition and we have already seen that the converse of O proposition does not follow validly from it. Given “Some cats are pets” we take the following steps:

Step 1: Obvert to “Some cats are not non-pets”

Step 2: Conversion not possible

E proposition: Like the case of O propositions, the contraposition for E propositions does not validity follow from the original. If we take “No cats are pets” as true then “No non-pets are non-cats” would be false. The reason is that when we try to apply the successive steps of first

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obversion then conversion and then obversion we find that in the first step we obvert E proposition to A proposition but we have already seen that the conversion of A propositions is possible only by limitation. In the third step we can obvert the converted proposition and attain contraposition by limitation. Given “No cats are pets” we take the following steps:

Step 1: Obvert to “All cats are non-pets”

Step 2: Convert to “Some non-pets are cats” (by limitation)

Step 3: Obvert to “Some non-pets are not non-cats” (Contraposition by limitation)

Contraposition of E proposition is valid by limitation. We have already seen in the section on conversion that A propositions are converted by limitation. Here a particular proposition is inferred from a universal proposition and therefore it cannot be logically equivalent to the proposition that was the original premise. Hence the resulting contrapositive premiss would not have the same meaning.

During the procedure of contraposition, as illustrated in the table, we neither change the quality nor the quantity of the original proposition. The contraposition of A proposition is an A proposition, contraposition of E proposition is E proposition and so on. It is important to note that according to modern logic contraposition by limitation is invalid.

S no.	Categorical Propositions	Premise	Contraposition
1.	A	All S is P	All non-P is non-S
2.	E	No S is P	Some non-P is not non-S (by limitation)
3.	I	Some S is P	Contraposition not valid
4.	O	Some S is not P	Some non-P is not non-S.

Table 3: Contraposition

9.6 SUCCESSIVE IMMEDIATE INFERENCES

Immediate inferences play a role in enhancing our knowledge. In Aristotelian logic we can use these inferences by repeatedly applying three immediate inferences of conversion, obversion and contraposition along with the immediate inferences based on Traditional Square of Opposition namely, Contradiction, Contrary, Subcontrary and Subalternation.

In order to find out whether a logical relation exists between two categorical propositions we can use these seven logical relations. Immediate inferences can help us resolve an issue like, in case we are presented with truth value of a statement what can we derive about the truth value of another given statement. For example:

Given that "No doctors are engineers" is true what can we infer about the truth-value of "Some non-engineers are doctors".

Solution:
Step 1: Obvert to "All doctors are non-engineers" True by obversion
Step 2: Convert to "Some non-engineers are doctors" True by (conversion by limitation).

Given that "All voters are citizens" is true what can we infer about the truth value of "No non-voters are non-citizens."

Solution:
Step 1: Contraposition to "All non-citizens are non-voters" True by contraposition.
Step 2: Convert to "Some non-voters are non-citizens" True by (conversion by limitation).
Step 3: If "Some non-voters are non-citizens" is true then "No non-voters are non-citizens" is false by contraposition.

There are several rules of thumb we can follow to understand these immediate inference which require us to use our learning from relations of traditional square of opposition as well as further immediate inferences. We should first look for exact match between subject and predicate of the two propositions; given and target propositions. In case there are differences between the two statements we should note which kind of differences exist. If the difference between the given and target propositions is of one complementary class then we can use obversion. If there is a difference in positioning of both the complementary terms we should explore the possibility of contraposition. If difference is of exchange of positions of subject and predicate terms then we can use conversion. Once we are able to arrive at the right match of subject and predicate terms in both the given propositions then we use the square of opposition to infer the truth value of the target statement in comparison with the truth value of the given statement. In cases where we cannot determine the truth value of the target statements by this process we would put the truth value as undetermined for our answer. As an action plan we should first try to get the subject and the predicate terms in the right order because unless two propositions do not have the same subject and same predicate terms there can be comparison among their truth values using traditional square of opposition. Secondly, we should try to eliminate the complementary terms by using immediate inferences of obversion and contraposition wherever applicable.

Also, in case the given proposition is false then we should begin drawing immediate inferences from either

1. Contradictory of the given proposition as contradictory of a false proposition would be true and therefore all valid inferences from that will also be true propositions.
2. From the target proposition itself as it would imply the proposition that is given as false and therefore all valid inferences from that will also be false propositions.(Copi et al., 2016, p. 121)

However, it is significant to note that as observed in the previous unit the Boolean interpretation has an impact on immediate inferences by limitation. Since the subalternation relation is not a valid relation in this interpretation therefore conversion by limitation for A proposition is invalid. For the same reason contraposition by limitation for E proposition will be invalid. The impact of Boolean interpretation for immediate inferences can be summed up as follows:

Conversion is valid for E and I.

Contraposition is valid for A and O.

Observion is valid for all propositions.

Conversion by limitation and contraposition by limitation is not valid.

Moreover, for the purpose of present block we are following the traditional Aristotelian logic and its explanation. Any reference to Boolean interpretation pertains to modern logic, which would be explored in the upcoming blocks of the course.

Check your Progress I

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

A. State converses of the following propositions. Also, indicate which of them are logically equivalent to the given propositions:

1. No umpires are partisans.
2. Some metals are conductors.
3. Some nations were not belligerents.
4. All dogs are animals.
5. Some animals are dogs.
6. Some women are writers.
7. All scientists are philosophers.
8. Some cats are pets.
9. No sinners are saints.
10. No non-artisans are professionals.

B. State obverses of the following propositions. Also, indicate which of them are logically equivalent to the given propositions:

1. No circles are polygons.
2. No radicals are students.
3. Some officers are soldiers.
4. No scholarship holders are students.
5. All non-students are non brave.
6. All red things are roses.
7. No roses are non-red things.
8. Some students are not non-brave.

9. No giraffes are short-necked.
10. No men are angels.

C. State the contrapositives of the following propositions. Also, indicate which of them are logically equivalent to the given propositions:

1. Some brave persons are not students.
2. No mortals are men.
3. All cats are mammals.
4. Some poets are not idealists.
5. All saints are polite.
6. Some professors are not good orators.
7. All dogs are intelligent beings.
8. All cats are mammals.
9. Some soldiers are officers.
10. No saints are martyrs.

D. If "All saints are pessimists" is true what can be inferred about the truth and falsehood of the following propositions? Which would be true, false or undetermined?

1. No saints are non-pessimists.
2. Some saints are not pessimists.
3. All non-saints are non-pessimists
4. Some non-pessimists are saints.
5. No non-pessimists are non-saints.

F. If "No pirates are merchants" is true what can be inferred about the truth and falsehood of the following propositions? Which would be true, false or undetermined?

1. All pirates are merchants
2. Some non-merchants are non-pirates.
3. Some non-pirates are non-merchants.
4. Some non-merchants are pirates.
5. All merchants are pirates.

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G. If “Some dogs are pets” is true what can be inferred about the truth and falsehood of the following propositions? Which would be true, false or undetermined?

1. Some pets are dogs.
2. Some non-pets are dogs.
3. No non-dogs are pets.
4. All dogs are non-pets.
5. Some dogs are not non-pets.

H. If “Some animals are not cats” is true what can be inferred about the truth and falsehood of the following propositions? Which would be true, false or undetermined?

1. No animals are cats.
2. No animals are non-cats.
3. All non-cats are non-animals.
4. Some non-cats are animals.
5. Some animals are non-cats.

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9.7 LET US SUM UP

Validity/Invalidity of Immediate Inferences according to Traditional Logic:

Immediate Inference	**Validity**
Conversion	Valid for E and I Invalid for O Valid by limitation for A
Obversion	Valid for A, E , I and O

Contraposition	Valid for A and O Invalid for I Valid by limitation for E

Validity/Invalidity of Immediate Inferences according to Modern Logic:

Immediate Inference	Validity
Conversion	Valid for E and I, Invalid for A and O
Obversion	Valid for A, E, I and O
Contraposition	Valid for A and O, Invalid for E and I

9.8 KEY WORDS

Complementary Class: The collection of all things that do not belong to a given class.

Contraposition: Firstly, we replace the subject term by the complement of its predicate term. Second, we replace the predicate term by the complement of its subject term. However, it is not a valid form of immediate inference for all types of propositions.

Conversion: To form the converse of a proposition the subject and predicate terms are simply interchanged. The original proposition is called “convertend” and the resultant proposition is called “converse.” However, it is not a valid form of immediate inference for all types of propositions.

Immediate Inferences: An inference which is drawn from one premise without the mediation of another premise.

Obversion: We first change the quality of a proposition from affirmative to negative, or from negative to affirmative. Second, we replace the predicate term with its complement. The original proposition is called the “obvertend” and the resultant proposition is called “observe.” It is a valid form of immediate inference for all types of propositions.

9.9 FURTHER READINGS AND REFERENCES

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9.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress I

A.

1. No partisans are umpires. Logically equivalent.
2. Some conductors are metals. Logically equivalent.
3. Conversion not valid.
4. Some animals are dogs (by limitation). Not logically equivalent.
5. Some dogs are animals. Logically equivalent.
6. Some writers are women. Logically equivalent.
7. Some philosophers are scientists (by limitation). Not logically equivalent.
8. Some pets are cats. Logically equivalent.
9. No saints are sinners. Logically equivalent.
10. No professionals are non-artisans. Logically equivalent.

B.

1. All circles are non-polygon. Logically equivalent.

2. All radicals are non-students. Logically equivalent.

3. Some officers are not non-soldiers. Logically equivalent.

4. All scholarship holders are non-students. Logically equivalent.

5. No non-students are brave. Logically equivalent.

6. No red things are non-roses. Logically equivalent.

7. All roses are red things. Logically equivalent.

8. Some students are brave. Logically equivalent.

9. All giraffes are non short-necked animals. Logically equivalent.

10. All men are non-angels. Logically equivalent.

C.

(A, B and C are the steps involved in the contraposition)

1. A. Some brave persons are non-students (by obversion)
B. Some non-students are brave persons (by conversion)
C. Some non-students are not non-brave persons (by obversion) Logically equivalent

2. A. All mortals are non-men. (by obversion)
B. Some non-men are mortals (conversion by limitation).
C. Some non-men are not non-mortals. (Contraposition by limitation) Not logically equivalent

3. A. No cats are non-mammals. (by obversion)
B. No non-mammals are cats. (by conversion)
C. All non-mammals are non-cats.(by obversion) Logically equivalent

4. A. Some poets are non-idealists. (by obversion)

B. Some non-idealists are poets. (by conversion)

C. Some non-idealists are not non-poets (by obversion) Logically equivalent

5. A. No saints are non-polite. (by obversion)

B. No non-polite are saints. (by conversion)

C. All non-polite people are non-saints. (by obversion) Logically equivalent

6. A. Some professors are non-good orators.(by obversion)

B. Some non-good orators are professors. (by conversion)

C. Some non-orators are not non- professors. (by obversion) Logically equivalent.

7. A. No dogs are non-intelligent beings. (by obversion)

B. No non-intelligent beings are dogs. (by conversion)

C. All non-intelligent beings are non-dogs. (by obversion) Logically equivalent.

8. A. No cats are non-mammals. (by obversion)

B. No non-mammals are cats. (by conversion)

C. All non-mammals are non-cats.(by obversion) Logically equivalent.

9. Not valid. Not logically equivalent.

10. A. All saints are non-martyrs. (by obversion)

B. Some non-martyrs are saints. (conversion by limitation)

C. Some non-martyrs are not non-saints. (by obversion) Not logically equivalent.

D.

1. Solution: Given that “All saints are pessimists” is true:

Then “No saints are non-pessimists”--- True, by obversion

2. Solution: Given that “All saints are pessimists” is true:

Then “Some saints are not pessimists” is false by contradiction

3. Solution: Given that “All saints are pessimists” is true

Step 1: “All non-pessimists are non-saints” True by contraposition

Step 2: Some non-saints are non-pessimists True by (conversion by limitation)

Step 3: Then “All non-saints are non-pessimists” is undetermined because from the truth of I nothing can be said about the truth value of corresponding superaltern A proposition.

4. Solution: Given that “All saints are pessimists” is true:

Step 1: “No saints are non-pessimists” --- True, by obversion

Step 2: “No non-pessimists are saints” ---True, by conversion

Step 3: Then “Some non-pessimists are saints” must be false by contraposition.

5. Solution: Given that “All saints are pessimists” is true:

Step 1: “All non-pessimists are non-saints”--- True, by contraposition

Step 2: Then “No non-pessimists are non-saints” must be false by contrary relation.

F.

1. Solution: Given that “No pirates are merchants” is true:

Then “All pirates are merchants” is false by contrary.

2. Solution: Given that “No pirates are merchants” is true:

Step 1: Some non-merchants are not non-pirates--- True, contraposition by limitation.

Then “Some non-merchants are non-pirates” is undetermined

3. Solution: Given that “No pirates are merchants” is true:

Step 1: No merchants are pirates--- True, conversion by limitation.

Step 2: Some non-pirates are not non-merchants--- True by contraposition by limitation.

Step 3: Then “Some non-pirates are non-merchants” is undetermined by relation of sub-contrary.

4. Solution: Given that “No pirates are merchants” is true:

Step 1: All pirates are non-merchants--- True, by obversion

Step 2: Then “Some non-merchants are pirates” is true, by (conversion by limitation)

5. Solution: Given that “No pirates are merchants” is true:

Step 1: No merchants are pirates--- True, by conversion by limitation

Then “All merchants are pirates” is false by contrary.

G.

1. Solution: Given that “Some dogs are pets” is true:

Then Some pets are dogs is true, by conversion by limitation

2. Solution: Given that “Some dogs are pets” is true:

Step 1: Some dogs are not non-pets--- True, by obversion

Step 2: The converse of target proposition is, “Some dogs are non-pets”

Since O is true I is undetermined.

3. Solution: Given that “Some dogs are pets” is true:

Step 1: Some pets are dogs--- True, by conversion (by limitation)

Step 2: Some pets are not non-dogs--- True, by obversion

Since the subject and predicate terms in the proposition obtained from step 2 are not same as the target proposition i.e. “No non-dogs are pets” the value is undetermined.

4. Solution: Given that “Some dogs are pets” is true:

Step 1: Some dogs are not non-pets--- True, by obversion

Then “All dogs are non-pets” is false by contradiction.

5. Solution: Given that “Some dogs are pets” is true:

Then “Some dogs are not non-pets” is true by obversion.

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H.

1. Solution: Given “Some animals are not cats” is true:
Then “No animals are cats” is undetermined because from the truth of O proposition nothing can be said with certainly about the truth value of corresponding superaltern E proposition.

2. Solution: Given “Some animals are not cats” is true:
Step 1: Some animals are non-cats--- True, by obversion
Then “No animals are non-cats” is false by contradiction.

3. Solution: Given “Some animals are not cats” is true:
Step 1: Some non-cats are not non-animals---True, by contraposition by limitation
Then “All non-cats are non-animals” is false by contradiction.

4. Solution: Given “Some animals are not cats” is true:
Step 1: Some animals are non-cats---True , by obversion
Step 2: Some non-cats are animals---True by conversion

5. Solution: Given “Some animals are not cats” is true:
Then “Some animals are non-cats” is true by obversion.

UNIT 6 INTRODUCTION TO FALLACIES[*]

Structure

10.0 Objectives
10.1 Introduction
10.2 Kinds of Fallacies
10.3 Kinds of Informal Fallacies
10.3 Let Us Sum Up
10.4 Key Words
10.5 Further Readings and References
10.6 Answers to Check Your Progress

10.0 OBJECTIVES

The objectives of this unit are,

- to introduce the kinds of fallacies in logic.
- to understand and elucidate various informal fallacies with suitable examples.
- To enable learner how to avoid these fallacies.

10.1 INTRODUCTION

One of the major 19th Century Mathematician and Logician, Gottlob Frege, rightly pointed out that the primary tasks of a logician are to distinguish incorrect reasoning from correct reasoning and to “indicate the *pitfalls* laid by language in the way of the thinker.” When the premises of an argument are unable to support its conclusion, such an argument is considered to be fallacious. For example, ‘This man is not intelligent because he cannot run fast’, exhibits fallacious reasoning. Thus, a *fallacy* can be understood as any kind of error or mistake in reasoning. As it must have already been discussed in the previous units, every argument in logic is governed by some axioms and when these axioms are violated, a fallacy occurs and the argument becomes invalid. In logic, a fallacy in fact signifies some typical mistakes in reasoning which can be recognized and named. Many arguments may serve as an example of a particular type of mistake in reasoning or a particular kind of fallacy. Let us consider an example, if from the fact that ‘All whales are mammals’ and ‘X is a mammal’; we conclude: ‘X is a whale’; the argument becomes fallacious. All whales are mammals, but not every mammal is a whale. The argument discussed in the example above is fallacious because the conclusion does not correctly follow from the premises. There is an error in reasoning in the given argument which may recur in different contexts. The kind of error here is in the *form* of argument and hence it is a kind of formal fallacy. Formal fallacies have been discussed in the unit dealing with categorical syllogisms. In this unit, we will focus on the more commonly occurring fallacies viz., informal fallacies. Informal fallacies arise due to mistakes in our everyday use of language. Thus, they pertain to the *content* of the argument. The language we use in speaking and writing can sometimes be imprecise, obscure and ambiguous - we need to know how to recognize these mistakes. This will help us to refrain from using fallacious arguments. There may be various sources of fallacies in our daily life such as: a lack of complete knowledge about the context, making false assumptions, misinterpretations, lack of attentiveness, a tendency to make generalized conclusions without considering sufficient number of cases, distractions of the mind, having some preconceived notions and prejudices, being swayed away by emotions, so on and so forth. We must use logic to identify such errors in reasoning and follow appropriate methods to tackle them. Further, we must also be fair in our examination and provide space for the use of natural language in everyday life. For example: the use of figures of speech like sarcasm, metaphor, irony etc. by writers in order to convey a particular meaning – in such cases we must be cautious as although the used argument may appear to be fallacious superficially but it may not actually be so.

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10.2 KINDS OF FALLACIES

There are two major types of fallacies.

a) Formal Fallacies
b) Informal Fallacies

10.2.1 Formal Fallacies

A formal fallacy arises when there is a fault in the form of a given argument. When a syllogism fails to adhere to any of the rules required for it to be a valid categorical syllogism then the fallacy occurred is formal. Some types of formal fallacies are as follows: Fallacy of Undistributed Middle, Fallacy of Illicit Major, Fallacy of Illicit Minor, Existential Fallacy, etc. As Formal fallacies have been discussed in detail with categorical syllogisms, let us go on to look at informal fallacies.

10.2.2 Informal Fallacies

There are various informal fallacies. Following I.M. Copi, they can be grouped under four major categories, viz., Fallacies of Ambiguity, Fallacies of Relevance, Fallacies of Defective Induction and Fallacies of Presumption. The following is the categorization within the four kinds of informal fallacies.

1) Fallacies of Ambiguity
    i) Fallacy of Equivocation
    ii) Fallacy of Amphiboly
    iii) Fallacy of Accent
    iv) Fallacy of Composition
    v) Fallacy of Division
2) Fallacies of Relevance
    i) The Appeal to Emotion (Argument *ad populum*)
    ii) The Red Herring
    iii) The Straw Man
    iv) The Argument Against the Person (Argument *ad hominem*)
        (a) Abusive
        (b) Circumstantial
    v) The Appeal to Force (Argument *ad baculum*)
    vi) Missing the Point or Irrelevant Conclusion (*Ignoratio elenchi*)
3) Fallacies of Defective Induction
    i) The Argument From Ignorance (Argument *ad ignorantiam*)
    ii) The Appeal to Inappropriate Authority (Argument *ad verecundium*)

    - iii) False Cause (Argument *non causa pro causa*)
    - iv) Hasty Generalization (Fallacy of *Converse Accident*)
4) Fallacies of Presumption
    - i) Fallacy of Accident
    - ii) Begging the Question (*petitio principii*)
    - iii) Complex Question

Let us discuss each of these fallacies and their sub-types along with illustrations.

10.3 KINDS OF INFORMAL FALLACIES

10.3.1 Fallacies of Ambiguity

The erroneous reasoning in this kind of informal fallacy occurs due to the equivocal use of words or phrases. In such cases, some term or phrase has a different meaning in one part of the argument than the same term or phrase in another part of the argument. When language is used in an inattentive and loose manner, such errors arise. It may be due to incorrect use of words or due to incorrect construction of statements. The five sub-types within Fallacies of Ambiguity are as follows:

10.3.1.1 Fallacy of Equivocation

The Fallacy of Equivocation arises when the same term or a phrase is used in a manner such that it has two different meanings in the same argument.

Let us consider the following examples:

- “I will abide by Gopal’s suggestion because he gives sound suggestions’. Another person says. “Yes, his sound is audible even from a far distance”. Thus, I can hear his suggestion even from a far distance. In this case, the term ‘sound’ has two different meanings. Firstly it means that which is based on valid reason or good judgment; reliable: he gives reliable suggestions. Secondly, the word ‘sound’ means the noise or vibrations produced while talking.

- John is a big writer because he is from a big city. Here, the term ‘big’ is a relative term. The meanings of relative terms differ in degrees from context to context. Thus, they cannot have the same meaning at different occurrences.

10.3.1.2 Fallacy of Amphiboly

The Fallacy of Amphiboly arises when the construction of the statement is such that it has more than one possible meaning.

As also pointed out in the examples above, in the cases of Fallacy of Equivocation the ambiguity lies in the *meaning* of a word or a phrase. Fallacy of Amphiboly refers to the ambiguity of a statement due to its grammatical *structure*.

Let us consider the following examples:

- “Kids make delicious dinners.”
  One meaning of the given statement can be that children prepare (cook) delicious meals. Another meaning of the statement can be that kids are delicious food item for dinner. Even though, the latter sounds ridiculous.
- “Mary ran to meet his 6 year old son, cheerful and happy.”
  One meaning of the above statement can be that Mary is cheerful and happy. The other meaning of the statement can be that her son is cheerful and happy.
- “Save water and waste paper.”
  The above statement can have two meanings. First, that one should save water but one can waste paper. Second, it can mean that one should save both ‘water’ as well as ‘waste papers’.
- Let us look at an example from the domain of mathematics. Suppose we are instructed that find a number ‘x’ that is equal to two times seven plus eight. The statement commits the fallacy of amphiboly, since the answer can be either:
  $[(2*7) + 8 = 22]$ or
  $[2*(7+8) = 30]$
  The above example shows us the importance of the use of correct punctuation marks in language, including the field of mathematics.

10.3.1.3 Fallacy of Accent

The Fallacy of accent arises when the meaning of a statement is changed or distorted by wrongfully stressing on or emphasizing some particular part (words) of it.

It is important to note that, the Fallacy of Accent, similar to the previously discussed, Fallacy of Amphiboly, is not an inferential fallacy. In our use of language, we do often emphasize a particular word or phrase to put forth a particular point. When, a word or a phrase, which was not emphasized in the original text by an author, is incorrectly emphasized upon later by someone else, the meaning of the statement changes. The elements such as accent, stress, tone etc., tend to change the meaning of the statements, often quite drastically. This in turn makes the argument fallacious.

Let us consider the following example:

- "Wife without her husband is nothing."

  The above statement would convey different meanings to husband and wife depending upon the emphasis on the term 'wife' or the term 'husband'. If the emphasis is on 'wife' then the meaning of the statement will be: For a wife, husband is important as she will be nothing without him. If the emphasis is on the term 'husband' then the meaning will be that for husband, wife is important as without her he will be nothing.

10.3.1.4 Fallacy of Composition

The Fallacy of Composition arises when the conclusion is drawn from the properties of the parts of a whole to the properties of whole itself. In this case, it is assumed that what is applicable to the parts is applicable to the whole as well. The fallacy occurs because the whole, the comprehensive set is regarded as the collection of its subsets.

Let us consider the following examples:

- Each and every player of the Indian Hockey team is an excellent player. Thus, the Indian Hockey team is an excellent team.

The given argument is fallacious because for a team to be excellent it is not just sufficient that it has players who are talented and skilled. What is also required for the proper and smooth functioning of a team are the key values of unity and team spirit.

- There can be another form of this fallacy in which one argues from a premise containing a term taken distributively to a conclusion in which the term is used collectively. For example, “An elephant eats more food than any other animal does. Therefore, elephants of Sanjay Gandhi National Park eat more food than all the other animals in the park.

The above example involves incorrect reasoning because even though an elephant in comparison with other animals may eat more food, yet collectively all the other animals, being greater in number, eat more food than all the elephants in the Park.

10.3.1.5 Fallacy of Division

The Fallacy of Division arises when the properties of its parts are drawn from the properties of whole. The Fallacies of Division and Composition are reciprocal fallacies. In case of Fallacy of Division, what is applicable only to the whole is erroneously predicated to its parts. So, it becomes incorrect to reason that since a particular football team is a good one, so each of its players must be good. Similarly, one may reason wrongly when one says what is good for the nation is also necessarily beneficial for each of its citizens.

Let us look at the following examples:

- Indians are fond of the game of Cricket.
  Ram is an Indian.
  Therefore, he is fond of the game of Cricket.
- No men desire the success of all.
  So, no man desires his own success.
  The above examples illustrate the Fallacy of Division,

It has become evident from our discussion so far that the fallacies of ambiguity occur due to a lack of knowledge, wrong interpretation and incorrect understanding.

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Check Your Progress I

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

1. When the fallacy of equivocation arises?

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2. When the fallacy of composition arises?

10.3.2 Fallacies of Relevance

Fallacies of Relevance arise when the premises of an argument are irrelevant to the conclusion for some reason. The premises may appear to be relevant to the conclusion initially, but on close analysis and examination, they are found to be inadequate. In this case, the premises of the argument may appear to be psychologically relevant but for a sound argument, the premises must be logically relevant rather than psychologically. There are mainly six sub-categories within this fallacy. They are as follows:

10.3.2.1 The Appeal to Emotion (Argument *ad populum*)

This fallacy arises when an argument is supported with the help of an appeal to emotions and not by reasoning. For example, a political speech may appeal to emotions in order to stir up love or hatred among the masses. Emotionally charged language is often used in order to manipulate the beliefs of the public and gather their approval or disapproval on some issue.

Let us consider the examples given below:

- In William Shakespeare's Julius Caser, when Mark Antony instigates the crowd to take revenge on Caesar's killing, he says, "... You all did love him once, not without cause: What cause withholds you then, to mourn for him? ..."
  It is evident that the phrases and arguments used in the speech appeal to emotions.
- 60 percent of people buy Motorola phones rather than any other brand. All these people cannot be wrong. Thus, Motorola is the best phone brand in the market.

  In this example, the conclusion is drawn and taken to be true on the basis of what many people popularly believe. However, the argument becomes fallacious as the soundness of reasoning should be judged not on the basis of popularity but on the relevance of the premises involved in the argument to the conclusion.

- "If we send this man to jail, who will feed his five little hungry and helpless kids. Therefore, in the interest of the poor children, pardon the man."

  In the above example we see that an appeal of special kind of emotions is being made viz., pity and sympathy. The argument appeals to the heart rather than to the head.

  The employment of emotionally laden and expressive language to support conclusions in arguments is not a logically acceptable approach. Thus, such arguments, which involve an appeal to emotions, are fallacious.

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10.3.2.2 The Red Herring

This fallacy arises when a deliberate attempt is made to distract or divert the attention of listener(s) from the original topic, with the intention to do away with the original issue under discussion. According to the ancient story, red herring was used to confuse or divert dogs. So, anything that can mislead and can keep the listener off the track can act as a 'red herring'.

Let us look at the example below:

- Mother (At 8.30 pm): It is time for you to go to bed.

Boy: Mummy, I feel hungry … I also have a stomach ache … I need to go to the bathroom …

In this case, the mother of a young boy tells him to go to bed as it is his bed-time. He in turn begins to talk about other issues such as, he is hungry, or he needs to go to the bathroom. Such statements are made to avoid the central topic of going to bed and to distract the mother. The fallacy committed here is The Red Herring.

10.3.2.3 The Straw Man

The Straw Man Fallacy occurs when one argues against an opponent's view by presenting the opponents position in a manner which can be easily refuted. The opponent's actual view is put forth in a distorted and misinterpreted manner and then refuted. The misconstrued and exaggerated version of the opponent's position which the arguer himself presents and then refutes is in fact like a 'straw man'.

Let us consider the following example:

- Jinsi is the class secretary. She suggests in the class meeting that the class should participate in more social service projects and programs. To this, Ram says that he cannot believe that Jinsi does not support the annual school dance program.

The above case involves erroneous reasoning. What Ram is refuting here is a misinterpreted version of Jinsi's viewpoint. Jinsi's view of encouraging and facilitating social service projects is misconstrued as a necessary disapproval of all the other events and activities of the school. This distorted version of Jinsi's view is attacked by the arguer. It is similar to attacking a straw man.

10.3.2.4 The Argument Against the Person (Argument *ad hominem*)

This fallacy arises in the following way. Person X makes an argument. Person Y evaluates the argument. Person Y shows that the argument made by X is wrong because either:

a) Person X carries a bad reputation and so his argument cannot be sound. (Abusive)

Or

b) Person X’s circumstances are questionable hence his argument cannot be sound. (Circumstantial)

In this type of fallacy, the argument is examined not on the basis of its premises but on the basis of the person making the argument, his circumstances etc. Personal emotions, interests, attitudes, prejudices etc., lead to this fallacy.

For example:

- Since he is a leftist, he will not favour the policy even if it beneficial for the people. (Abusive)
- Since he works for Amazon, he will naturally give arguments in favour of e-commerce. We cannot believe him. (Circumstantial)

10.3.2.5 The Appeal to Force (Argument *ad baculum*)

This fallacy arises when an arguer threatens his opponent with some undesirable or unpleasant consequences if his viewpoint is not accepted. This appeal to force doesn’t necessarily involve physical force or threat but can also use subtle threats to persuade the other person. In logic, accepting a conclusion merely based on threat is not sound.

For example:

- The auto drivers often threaten the authorities that if their demands are not met, they will go on strike.
- “Give me your wallet or else look at the knife in my hand.”

10.3.2.6 Missing the Point or Irrelevant Conclusion (*Ignoratio elenchi*)

This fallacy is committed when instead of proving what is intended, we prove something different. That is to say, the premises imply something other than the conclusion which they are supposed to imply. *Ignoratio elenchi* means “ignoring the conclusion to be proved” and instead “proving the wrong conclusion.”

This can be further understood by looking at the example given below.

- The object of war is peace therefore army soldiers are the best peacemakers.

  This argument commits the Fallacy of Irrelevant Conclusion as even if it is assumed that the object of war is peace, still it does not imply that army soldiers are the best peacemakers. Since the premise misses the point, this fallacy is also called "Missing the Point".

Check Your Progress II

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

1. What does Fallacy of *straw man* mean?

10.3.3 Fallacies of Defective Induction

In the Fallacies of Defective Induction, the premises of the argument may be relevant to the conclusion but they are too weak to support the conclusion. This will be further clarified when we look at the four sub-types under this fallacy along with an example of each.

10.3.3.1 The Argument From Ignorance (Argument *ad ignorantiam*)

This fallacy arise when it is argued that a proposition is true on the basis that it has not been proved false, or when it is argued that a proposition is false because it has not been proved to be true.

For example:

- There is no evidence that cigarette smoking causes lung cancer. Thus, cigarette smoking does not cause lung cancer.

Here, the appeal is made to ignorance rather than to knowledge. The fact that it has not been definitely proven yet that smoking leads to cancer, it does not imply conversely that smoking does not cause cancer.

10.3.3.2 The Appeal to Inappropriate Authority (Argument *ad verecundium*)

This fallacy arises when the authority who is cited, does not have enough credibility to judge the issue at hand.

Let us consider the following example:

- When some famous Bollywood actor says that a particular brand of tea is good and it is accepted as good; it is fallacious. The actor is not authority to judge the quality of tea. He is an authority in the field of acting and entertainment. Had he recommended a particular acting school, his words would have been reliable. But in the domain of tea, he does not have credibility as he is not an expert.

10.3.3.3 False Cause (Argument *non causa pro causa*)

This fallacy is committed when a non-causal event is assumed to be either a cause or part of a cause of an effect. That is to say, in such cases, a causal relationship is assumed to exist when actually there is none.

For example:

- Harry drinks ‘Rasna’ with water every day. That is the cause of his good performance in studies.

- When the building got burnt, the sun was shining bright. Thus, the bright shining sun is the cause of the building burning.

The above example shows another form of the Fallacy of False Cause called *Post hoc ergo propter hoc*. It means, ‘after the thing, therefore, because of the thing’. Although temporally, a cause is always prior (antecedent) to the effect, yet to say that every antecedent event is necessarily the cause of the following event is fallacious.

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10.3.3.4 Hasty Generalization (Fallacy of *Converse Accident*)

The Fallacy of Hasty Generalization arises when it is argued in a careless and quick manner from one or very few instances to a very broad or universal claim. In this fallacy, a general rule is formed on the basis of very few instances.

For example:

- To give charity to healthy beggars is wrong. Thus, charity of all kinds is wrong.

  In this example, even though few cases/instances of fit and healthy beggars stop us from giving them charity. It is erroneous to form a universal claim that all kinds of charity are wrong. There can be people who are poor and needy and genuinely require support.

10.3.4 Fallacies of Presumption

Fallacies of Presumptions are committed when unnecessary presumptions are made prior to making an argument. The premises already presume to be true (without evidence) what they aim to prove. There are three major sub-categories under this:

10.3.4.1 Fallacy of Accident

This fallacy occurs when general or universal claim is erroneously applied to an individual case which is not properly governed by that general claim.

For example:

- In the moral domain, when we look at the universal moral dictum, it is true that lying is a sin but if in order to save lives, one lies, it would not be wrong. So, to presumably say that all acts of lying are wrong, without taking into consideration some special circumstances is fallacious.

10.3.4.2 Begging the Question (*petitio principii*)

This fallacy arises when the conclusion or some part of the conclusion is already stated in the premises either explicitly or in some slightly different form. This fallacy of *Petitio Principii* is also called ‘reasoning in a circle’ because the conclusion is already present in the evidence, out of one's eagerness to prove it. The reasoning involved becomes superfluous as the conclusion is already assumed.

For example:

- Ram is a good student because he spends more time studying. He spends more time studying because he is a good student.

This argument involves 'reasoning in circle'.

10.3.4.3 Complex Question

This fallacy arises when a question is asked in such a way that it assumes or presupposes the truth of some facts hidden in it (question). In this fallacy, often a single question is asked but two or three questions are wrapped up in it. Thus, it is also called 'Fallacy of Many Questions'.

Let us consider the example given below,

- "Have you stopped being careless with your work?"

In this case, there are two question involved. First, 'Did you ever have a tendency of being careless towards your work?" and second, "Have you given up that attitude now?". Further, an affirmative answer to the question asked in the example presumes that earlier the person had a careless attitude towards his work.

An adequate knowledge about all the various informal fallacies, as discussed above, helps us to avoid mistakes in reasoning and enables us to always use correct reasoning while framing arguments.

Check Your Progress III

Note: a) Use the space provided for your answer.

b) Check your answers with those provided at the end of the unit.

1. Check the fallacy in the following statements:

   i. Haldiram's is a famous restaurant because they serve delicious food. Haldiram's serves delicious food because it is a famous restaurant.

ii. "Have you stopped drinking alcohol?"

iii. IIT Bombay is the best institute in the country; therefore every student of IIT Bombay must be the best student in the country.

iv. Since Sachin Tendulkar promotes Toshiba TV, therefore Toshiba TV must be good.

10.4 LET US SUM UP

In this unit we have discussed informal fallacies, the four main kinds of informal fallacies, viz., Fallacies of Ambiguity, Fallacies of Relevance, Fallacies of Defective Induction and Fallacies of Presumption. In this unit we have also covered the sub-categories within each of these four broad categories of informal fallacies along with adequate examples. The wider scope of the unit consists in looking at the kinds of errors and mistakes the human mind is prone to make when we use arguments in our day to day life. The illustrations provided from our everyday use of natural language helps to facilitate better understanding. The informal fallacies involve those fallacies which may occur when we use language incorrectly in making arguments.

10.5 KEY WORDS

Fallacy: an error in reasoning.

Formal Fallacy: fallacies that occur in the 'form' of an argument.

Informal Fallacy: fallacies that occur in the 'content' of an argument.

10.6 FURTHER READINGS AND REFERENCES

- Read, Carveth. *Logic: Deductive and Inductive*. Dodo Press, 1914.
- Copi, I.M. *Introduction to Logic*. New Delhi: Prentice Hall India, 9th Ed., 1995.

10.7 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress I

1. The Fallacy of Equivocation arises when the same term or a phrase is used in a manner such that it has two different meanings in the same argument.

2. The Fallacy of Composition arises when the conclusion is drawn from the properties of the parts of a whole to the properties of whole itself.

Check Your Progress II

1. The Straw Man Fallacy occurs when one argues against an opponent's view by presenting the opponents position in a manner which can be easily refuted. The opponent's actual view is put forth in a distorted and misinterpreted manner and then refuted. The misconstrued and exaggerated version of the opponent's position which the arguer himself presents and then refutes is in fact like a 'straw man'.

Check Your Progress III

i. Fallacy of *Petitio Principii*
ii. Fallacy of Complex Question
iii. Fallacy of Division
iv. Fallacy of Appeal to Inappropriate Authority

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Block 3

CATEGORICAL SYLLOGISM

Block 3 “Categorical Syllogism”, comprised of 4 units, discusses categorical syllogism, non-categorical syllogism, and propositional logic. Study of this block will enable learners to understand the distinction between traditional and modern logic and the need for modern or symbolic logic as well.

Unit 11 “Nature of Categorical Syllogism” aims to introduce and discuss the definitions of syllogism and categorical syllogism; basic terms of categorical syllogism; the form of a categorical syllogism, the distinction between the standard form categorical syllogism and non-standard form categorical syllogism; the notion of validity and invalidity of standard form categorical syllogism.

Unit 12 “Methods for Testing Categorical Syllogism” introduces mainly two methods for testing categorical syllogism. The unit discusses the Classical technique (developed by Aristotle) and Venn diagram technique to test the validity of a categorical syllogism.

Unit 13 “Non-categorical Syllogism” discusses the two major kinds of non-categorical syllogisms, namely: disjunctive syllogism and hypothetical syllogism. This unit also elaborates another kind of non-categorical argument called dilemma; the different types of dilemmas and the ways to tackled/resolved dilemmas.

Unit 14 “Propositional Logic” introduces learners to Propositional Logic. Understanding Propositional Logic is crucial to understand the development of Modern Logic or Symbolic Logic. This unit also helps learners to understand the techniques used by Propositional Logic to test the truth and validity in Logical expressions. This unit also briefly mentions the parallels of Propositional logic in Indian Logic.

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UNIT 11 NATURE OF CATEGORICAL SYLLOGISM[*]

Structure

11.0 Objectives

11.1 Introduction

11.2 Definition

11. 3 Form of Categorical Syllogism

11.4 Nature of Categorical Syllogism

11.5 Let Us Sum Up

11.6 Key Words

11.7 Further Readings and References

11.8Answers to Check Your Progress

11.0 OBJECTIVES

This unit entitled Nature of Categorical Syllogism aims to:

- Introduce and discuss the definitions of syllogism and categorical syllogism. The unit also introduces the basic terms of categorical syllogism.
- Discuss the form of a categorical syllogism, distinction between the standard form categorical syllogism and non-standard form categorical syllogism
- Discuss moods and figures that make the form and their importance in evaluating a categorical syllogism.
- Discuss the notion of validity and invalidity of standard form categorical syllogism.

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11.1 INTRODUCTION

Propositions are the building blocks of arguments. Arguments in turn are considered the basic unit of reasoning. We use different kinds of arguments in our day to day lives for different purposes ranging from normal conversations to strict logical reasoning and professional decision-making. In all these activities, some arguments are able to convince others sooner than some other arguments. For example, in a court room, the advocate who is able to produce more robust arguments from the available facts is most likely to win the case. In logic, the argument is evaluated in terms of validity and soundness, and not on the basis of its convincing ability. An argument can be very convincing yet could turn out to be invalid. In this unit, we will discuss a kind of argument which is distinct from other kinds of arguments because of its formal nature, namely categorical syllogism. We will look at the key features of a categorical syllogism, the terms involved, the moods of categorical syllogism and the figures in which these moods can be found. Mood and figure taken together constitute the form of a categorical syllogism. As for any argument, the notion of validity and invalidity is important, so it will also be discussed in the context of our topic of categorical syllogism.

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11.2 DEFINITION

To begin with, a *syllogism* may be defined as any deductive argument which has three propositions out of which the first two are called premises and third is conclusion and the conclusion is entailed by those two premises.

For example,

All Men are Stupid.
Mohan is a Man.
Therefore, Mohan is Stupid.

If all the three propositions of a syllogism are categorical propositions (namely, A, E, I, O) then the syllogism is called a *categorical syllogism*. This distinction was maintained by traditional logicians, but for the modern logicians starting from Boole, only a categorical syllogism can be of syllogistic nature. In other words, it will not be called a syllogism, unless it is categorical.

Therefore, modern logicians use the word syllogism and categorical syllogism interchangeably. However, any three propositions even if categorical, grouped together, would not result into a categorical syllogism, as pointed out earlier; the conclusion should be necessitated by the other two premises. The three propositions in categorical syllogism must consist only three terms as their subjects and predicates, each of which occurs twice.

Let us look at the example below to understand a categorical syllogism:

All Ministers are Members of council of Ministers.
All Members of council of ministers are Politicians.
Therefore, All Ministers are Politicians..

In the above example, there are three categorical propositions (all of them are Universal Affirmative, A, in this case), and there are three terms namely, ‘Ministers’, ‘Members of Cabinet of Ministers’ and ‘Politicians’, and each of these terms has occurred twice in the syllogism.

However, in order to find out the validity or the invalidity of a categorical syllogism, the syllogism must be in its *standard form*. A categorical syllogism in its standard form is called standard form categorical syllogism. We will discuss in the next section how a categorical syllogism is changed in its standard form, what is the form of a categorical syllogism and other questions related to standard form of categorical syllogism.

11.3 FORM OF CATEGORICAL SYLLOGISM

We can find out the validity of a categorical syllogism only when the syllogism is in the standard form because the rules of the validity and invalidity of a syllogism are applicable only to the standard form syllogism. In the standard form categorical syllogism, the categorical propositions forming the syllogism must be in a *particular order*: the first proposition in this order is called major premise, the second is called minor premise and the third proposition is called conclusion. If a given categorical syllogism whose validity is to be checked is not given in the standard form, then one must convert it into the standard form before determining its validity. Let’s consider the example that was mentioned in the previous section,

All Ministers are Members of council of Ministers.

All Members of council of Ministers are Politicians.
Therefore, All Ministers are Politicians.

How we can find out whether the given syllogism is in the standard form or not? In order to check that, the first thing that is required is to identify the proposition that is serving as the conclusion in the given syllogism. The conclusion can be located by identifying certain conclusion indicators, such as, 'therefore', 'thus', 'hence', 'subsequently', 'so', 'consequently', so on and so forth. Sometimes, a syllogism may contain no conclusion indicators and in that case one can look for premise indicators. Some premise indicator words are: 'since', 'for', 'because' etc. If a premise is identified (by a premise indicator) then the other proposition in conjunction with this premise would be the other premise. And the remaining proposition would be the conclusion of the syllogism. In the considered example, the conclusion is evident because of the conclusion indicator 'therefore' being present:

So the conclusion here is- 'All Ministers are Politicians.'

Now, once the conclusion is identified, we can look for the method that would help us determine which of the premises is to be called minor and which is to be called major. A major premise is the one which contains the major term and minor premise which contains the minor term. There is another term which is called middle term. The method to identify these terms and their relation with each other is explained in the next subsection.

11.3.1Terms of Categorical Syllogism

As mentioned earlier in the introductory section, a categorical syllogism consists of only three terms, namely - middle term, minor term and major term. Once we have identified the conclusion of a categorical syllogism, it is very easy to identify the three terms of the syllogism.

The subject term of the conclusion is called minor term and the premise containing that term is called minor premise. This occurrence of minor term is other than in the conclusion as each of the terms appears twice in a categorical syllogism. The predicate term of the conclusion is called major term and the premise containing the major term is called major premise. Again, this occurrence of major term is other than in the conclusion as each of the terms appears twice in a categorical syllogism. There is a third term which is present in both the premises but is not present in the conclusion; this third term is called middle term. The commonly accepted denotation for major, minor and middle terms are P, S and M, respectively.

The conclusion of a categorical syllogism asserts the relation between the classes represented by the major and the minor terms and this relation is a product achieved by the relation of minor term and major term with the middle term.

So considering the example mentioned earlier, we can now identify which term is which. The conclusion is - All Ministers are Politicians.

Major term in this case is - Politicians

Minor term in this case is - Ministers

The third term which is not present in the conclusion but is there in other two propositions (premises), middle term, in this case is – Members of council of Ministers.

Now, it becomes clear that the categorical syllogism as given to us is not in its standard form, for the minor premise is placed before the major premise. So let us arrange it to get the standard form categorical syllogism,

Major Premise: All Members of council of Ministers are Politicians.
Minor Premise: All Ministers are Members of council of Ministers.
Conclusion: All Ministers are Politicians.

Now if we replace these terms with their standard denotation, we will get

All M is P
All S is M
Therefore, All S is P

11.3.2 Mood of a Categorical Syllogism

The arrangement of premises and conclusion in a syllogism, essentially gives the mood of a syllogism. Once a syllogism has been arranged into a standard form categorical syllogism, then writing the denotations of the categorical propositions used, would give us the sequence known as mood of the syllogism.

Considering the syllogism discussed in the previous section, we have it in its standard form,

That is: All M is P (A)
All S is M (A)
Therefore, All S is P (A)

Here, all the three categorical propositions are of A form. Hence, the mood of this syllogism is AAA.

Example: Let us consider another categorical syllogism and try to determine its mood,

Some Scholars are Students.
All Students are Brave.
Therefore, Some Scholars are Brave.

To decide the mood of the argument, first we need to see whether the syllogism is in its standard form or not. So the conclusion, 'Some Scholars are Brave' gives us the predicate (major term) and the subject (minor term), i.e., 'Brave' and 'Scholars' respectively. Once we have our major and minor terms, we can see that the third term, 'Students' is the middle term. It also becomes evident that the syllogism is not in its standard form yet. So, we restructure it to follow the standard form- that is, major premise, followed by minor premise, followed by conclusion. We get the standard form categorical syllogism as:

Major premise: All Students are Brave.
Minor Premise: Some Scholars are Students.
Conclusion: Some Scholars are Brave.

Replacing these terms by their standard denotations, we will get:

All M is P (A)
Some S is M (I)
Therefore, Some S is P (I)

Hence the mood of the syllogism here is AII.

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Now, one can see that there could be so many syllogisms which will have a common mood, no matter what their content is, yet a logical form cannot be determined solely on the basis of the mood of the argument. The reason why it is not possible to determine the logical form of a syllogism solely on the basis of mood is because the factor of the positioning of these terms (middle term, major term and minor term) is not being taken into account. Middle term can either be the subject or the predicate in both major and minor premises and yet the mood will not change if there is no qualitative change in the propositions. So, there is another factor known as figure of the syllogism which taken together with mood provides us with the logical form of the categorical syllogism

11.3.3 Figures of Categorical Syllogism

Figures of categorical syllogisms are determined by the position of the middle term in the premises of any given categorical syllogism. The middle term (M) can appear in four ways in a standard form categorical syllogism. One must make sure that the order of the propositions is according to the standard form, i.e., major premise, minor premise, and conclusion, before one tries to identify the figure of the syllogism.

i. First Figure: M P
S M
Therefore, S P

In the first figure, the middle term is the subject in the major premise and it is the predicate in the minor premise.

ii. Second Figure: P M
S M
Therefore, S P

In the second figure, the middle term is the predicate in both the premises.

iii. Third Figure: M P
M S
Therefore, S P

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In the third figure, the middle term is the subject in both the premises.

iv. Fourth Figure: P M
M S
Therefore, S P

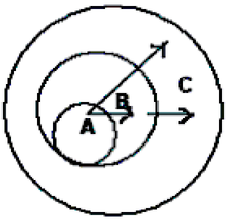
In the fourth figure, the middle term is the predicate in the major premise and it is the subject in the minor premise.

From the scheme of the four figures discussed above, it is clear that neither P nor S determines the figure of syllogism. As per historical records, Aristotle accepted only the first three figures. The origin of the fourth figure remains disputed. While Quine said that Theophrastus, a student of Aristotle, invented the fourth figure, Stebbing said that it was Gallen who invented the fourth figure. This dispute is not very significant. But what Aristotle says on the first figure is rather significant. Aristotle regarded the first figure as most ‘scientific’ one. It is likely that by ‘scientific’ he meant ‘satisfactory’. One of the reasons, which Aristotle has adduced in defense of his thesis, is what the nature of laws of mathematics and physical sciences suggest.

Aristotle argued that the sciences often establish laws in the form of the first figure. Second reason is that a reasoned conclusion or a reasoned fact is generally found, according to Aristotle, in the first figure. Aristotle believed that only universal affirmative conclusion can provide complete knowledge and universal affirmative conclusion is possible only in the first figure. Aristotle quotes the fundamental principle of syllogism. ‘One kind of syllogism serves to prove that A inheres in C by showing that A inheres in B and B in C’. This principle can be expressed in this form:

Minor: A inheres in B
Major: B inheres in C
Therefore, A inheres in C

Evidently, this argument satisfies transitive relation. This can be further clearly illustrated with the help of the following diagram.



Keeping the structure in mind, let us consider an example, corresponding to each of the four figures:

First figure:

All Artists are Poets. (major premise)
All Musicians are Artists. (minor premise)
Therefore, All Musicians are Poets. (conclusion)

Second figure:

All Saints are Pious. (major premise)
No Criminals are Pious. (minor premise)
Therefore, No Criminals are Saints. (conclusion)

Third figure:

All Great Works are Worthy of Study. (major premise)
All Great Works are Epics. (minor premise)
Therefore, Some Epics are Worthy of Study. (conclusion)

Fourth figure:

No Soldiers are Traitors. (major premise)
All Traitors are Sinners. (minor premise)
Therefore, Some Sinners are not Soldiers. (conclusion)

The above discussed examples make the schematic structure of the four types of figures of categorical syllogism clear.

Check Your Progress I

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Note: (a) Use the space provided for your answer.

(b) Check your answers with those provided at the end of the unit.

1. Give an example of AAA-1.

11.3.4 Evaluation of the Form of Categorical Syllogism

Mood and figure taken together provide the form of categorical syllogism. Consider the example of a categorical syllogism given in the beginning of this section

All Ministers are members of council of ministers.
All Members of council of Ministers are Politicians.
Therefore, All Ministers are Politicians.

When we convert this categorical syllogism to obtain the standard form categorical syllogism we get:

All Members of council of Ministers are Politicians
All Ministers are Members of council of Ministers
All Ministers are Politicians

This standard form when converted into standard denotations gives us:

All M is P
All S is M
Therefore, All S is P

This gives us the mood of the categorical syllogism as AAA. Now if we notice the position of the middle term, we find that in the major premise, middle term is in subject's position and in the minor premise, it is in predicate's position, which is the condition of figure 1.

Hence the form of the syllogism is AAA-1.

Example 1: Consider another argument:

Some Cricketers are Athletes.
All Cricketers are Runners.
So, Some Runners are Athletes.

This would give us:

Some M is P
All M is S
Some S is P

It is evident that the mood of the syllogism is IAI and the position of middle term gives figure 3. Both of these taken together give us the logical structure as IAI-3.

Example 2: Let us consider another categorical syllogism,

All Phoenix are Immortals.
No One who ever dies is Phoenix.
Therefore, No One who ever dies is Immortal.

In the above example, the mood of the categorical syllogism is AEE. On replacing the terms with their denotations, we get:

All M is P
No S is M
Therefore, No S is P

It is evident from the position of the middle term in the premises that the figure of the categorical syllogism is 1. Hence, the form of the syllogism is AEE-1.

In the context of figures and moods of categorical syllogism, it is important to keep in mind that, there are exactly 256 distinct forms of categorical syllogism: four kinds of major premise (categorical propositions A, E, I, O), multiplied by four kinds of minor premise, multiplied by four kinds of conclusion, multiplied by four relative positions of the middle term (figures). That is to say, there are three categorical propositions in each categorical syllogism and four types (A,

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E, I, O) or 4^3 (4*4*4) = 64 possible combinations or arrangements (moods). Further, with four figures possible for each of 64 moods there are (64*4) 256 total possible arrangements of mood and figure. Out of these distinct and unique 256 forms that standard form categorical syllogisms may assume, only some possible forms are valid forms. Each of the valid forms also has a unique name associated with it. This will be discussed in further more detail in the upcoming unit on 'Techniques for Testing the Validity of Categorical Syllogism'.

Check Your Progress II

Note: (a) Use the space provided for your answer.

(b) Check your answers with those provided at the end of the unit.

1. Point out the major term, minor term and middle term of the given syllogism. Also give the mood and figure.
   a. All Sharks are Biters. Some Fishes are Sharks. Therefore, Some Fishes are Biters.
   b. Some Dogs are Dangerous. Some Cats are Dangerous. Hence, Some Cats are Dogs.
   c. Some Four-wheeler Vehicles are Cars. No Cars are Solar-powered Vehicles. Therefore, Some Four-wheeler Vehicles are not Solar-powered Vehicles.

11.4 NATURE OF CATEGORICAL SYLLOGISM

It is important to note that one of the primary concerns of logic is to deal with validity of arguments. A categorical syllogism is formal in nature. So, the analysis of the syllogism pertains to its logical structure or form and not it's content per se. In a standard form categorical syllogism, the assumption about the truth value of its constituent proposition is taken to be contingent. Therefore, the validity or the invalidity of syllogisms remains unaffected from the content of the propositions. The validity and the invalidity are tested against the form of a syllogism. A corollary to this character is that two syllogisms which may have completely different content in their propositions, would share the validity or the invalidity if they share a form. Either both of them would be true or both of them would be false, independent of the content of their propositions.

This feature of formal validity enables us to employ the tools of 'logical analogies' in our everyday usage of arguments. Logical analogy is very frequently used in debates and discussions to prove the validity of one's own argument and to prove the invalidity of the argument of one's opponent. The method of logical analogy is a testimony to the fact that the validity or the invalidity arising out of form (formal structure) is independent of specific content.

11.4.1 Axioms of Categorical Syllogism

There are six axioms that govern the formation of a standard form categorical syllogism. The rules are listed as follows.

11.4.1.1 Axioms of Quantity (Axioms pertaining to distribution of terms):

i. The middle term must be distributed at least one time in any of the premises.
ii. A term which is undistributed in the premise must remain undistributed in the conclusion as well.
iii. A term which is distributed in the conclusion should necessarily be distributed in the premise.

11.4.1.2 Axioms of Quality:

i. Two negative premises do not lead to any conclusion.
ii. Affirmative premises give only affirmative conclusion.
iii. Negative premise (given that there can be only one negative premise) leads to only negative conclusion.

Each of these rules, when broken gives rise to a specific fallacy. Further, the fallacy so occurred - occurs in the *form* of the syllogism and is called a formal fallacy. There are different types of formal fallacies. These rules in turn can be used to test the validity of a given categorical syllogism. This method of testing validity of categorical syllogisms is called the Traditional or Aristotelian Technique. These rules and the associated fallacies will be discussed in detail in the upcoming unit on 'Techniques for Testing the Validity of Categorical Syllogism'.

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11.5 LET US SUM UP

Syllogism is an important form of inference in traditional Aristotelian logic. It is a deductive argument in which a conclusion is inferred from two premises. The structure of a categorical syllogism is determined by moods and figures. Mood is determined by the arrangement of the categorical propositions (premises and conclusion) involved in the syllogism. The position of the middle term determines the figure to which syllogism belongs. Mood and figure of a categorical syllogism together provide a unique way of describing the logical structure of each categorical syllogism. The validity or the invalidity of syllogisms remains unaffected from the content of the propositions. The validity and the invalidity are tested against the form (logical structure) of a syllogism.

Check Your Progress III

Note: (a) Use the space provided for your answer.

(b) Check your answers with those provided at the end of the unit.

1. Point out the conclusion, premises and the middle term in the given argument. (Note: Always change the syllogism into standard form first, if it is not already in standard form.)

a. All Saints are Polite. No Sinners are Saints. Therefore, No Sinners are Polite.
b. All Eagles are Birds. Some Birds are Herbivores. Therefore, Some Herbivores are Eagles.

11.6 KEY WORDS

Categorical syllogism: A categorical syllogism is an argument which consists of exactly three categorical propositions (A, E, I, O - two premises and a conclusion) in which there are exactly three categorical terms, each of which occurs exactly twice.

Major premise: The first categorical proposition in a standard form categorical syllogism is the major premise. It introduces the major term.

Major term: The term occurring in the predicate of the conclusion in a categorical syllogism.

Middle term: The term occurring in both the major and the minor premises of a standard form categorical syllogism.

Minor premise: The second categorical proposition in a standard form categorical syllogism is the minor premise. It introduces the minor term.

Minor term: It is the subject of the conclusion.

Mood: Mood of a categorical syllogism is determined by the arrangement of the three propositions.

Figure: It is determined by the middle term.

Standard form categorical syllogism: Standard form of a categorical syllogism is the form in which a syllogism is said to be when its premises and conclusion are all standard form categorical propositions (that is, A, E, I, or O) and are arranged in standard order that is, major premise, then minor premise, and then conclusion.

Syllogism: A syllogism is any deductive argument in which a conclusion is inferred from two premises.

11.7 FURTHER READINGS AND REFERENCES

Baronett, Stan. *Logic*. New Jersey: Prentice Hall, 2008.

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Copi, I. M., and Carl Cohen. *Essentials of Logic*. 2nd ed. Upper Saddle River, N.J.: Pearson Prentice Hall, 2007.

Priest, Graham. *Logic*. New York: Sterling Publishing. 2010.

11.8 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress I

All graduates are Poets. (major premise)
All Musicians are graduates. (minor premise)
Therefore, All Musicians are Poets (conclusion)

Check Your Progress II

1.

a. Major term: Biters, Minor term: Fish, Middle term: Sharks, Mood: AII, Figure: First (AII-1).
b. Major term: Dogs, Minor term: Cats, Middle term: Dangerous, Mood: III, Figure: Second (III-2).
c. Major term: Solar-powered Vehicles, Minor term: Four-wheeler Vehicles, Middle term: Cars, Mood: IEO, Figure: Fourth (IEO-4).

Check Your Progress III

1.

a. The syllogism is already given in standard form. Conclusion: Therefore, No Sinners are Polite, Major premise: All Saints are Polite, Minor premise: No Sinners are Saints, Middle term: Saints.
b. The syllogism is already given in standard form. Conclusion: Therefore, Some Herbivores are Eagles, Major premise: All Eagles are Birds, Minor premise: Some Birds are Herbivores, Middle term: Birds.

UNIT 12 METHODS FOR TESTING CATEGORICAL SYLLOGISM: ARISTOTELIAN AND VENN DIAGRAM[*]

Structure

12.0 Objectives

12.1 Introduction

12.2 Methods

12.3 Further exposition on Categorical Syllogism

12.4 Let Us Sum Up

12.5 Key Words

12.6 Further Readings and References

12.7 Answers to Check Your Progress

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12.1 OBJECTIVES

The objective of the unit is to introduce the methods for testing categorical syllogism. It must be clear by now that an argument is tested for its validity. This unit will enable learner;

- to use the Classical technique to test the validity of categorical syllogism.
- to use the Venn diagram technique to test the validity of categorical syllogism.

12.1 INTRODUCTION

A syllogism, in the most general terms, can be defined as a deductive argument with three propositions where two of them serve as premises and the third one is the conclusion based on the premises. If all the three prepositions are categorical proposition, the syllogism thus obtained is called categorical syllogism. In order to test the validity or the invalidity of a categorical syllogism, the first requirement is that we must restructure the given categorical syllogism into its standard form. We can apply any technique, be it the traditional Aristotelian technique or technique of Venn diagram, only when the syllogism is in its standard form. A standard form categorical syllogism has a certain fixed order in which its constituent proposition should be arranged. The first proposition is major premise; the second is minor premise, followed by conclusion.

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Aristotelian method of testing the validity of categorical syllogisms can be seen as a corollary to the six rules or axioms of the formation of categorical syllogism. If those six rules are followed in the construction of a syllogism, the syllogism thus formed would be a valid syllogism in principle. The unit will provide a detailed illustration of the six rules and in addition to that the fallacies which arise when one or more than one of these six rules are broken.

In the Venn diagram method, after restructuring a given categorical syllogism into standard form, we need to draw the Venn diagram of the given standard form categorical syllogism. Since the most important aspect of Venn diagram technique to test the validity of categorical syllogism is to be able to represent the categorical syllogism in Venn diagrams, the unit would provide a recapitulation of how categorical prepositions are represented in Venn diagrams.

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12.2METHODS/TECHNIQUES

12.2.1 Aristotelian Technique

A syllogism can fall short of establishing its conclusion from its premises in more than one ways. The rules prescribed in traditional logic work as a prescription for anyone trying to use syllogisms, so that he or she may be able to form a valid argument. These rules are six in number. To test the validity of a given categorical syllogism, one should start with these rules - testing the syllogism against each one of them one by one, and if it is found that one of these rules is not being followed, it can be argued immediately that the given syllogism is invalid, without checking other rules. However, this does not imply that any given syllogism cannot have more than one fallacy. The rules are explained as follows:

12.2.1.1 Rule 1: Avoidance of more than three terms

A categorical syllogism, by definition contains only categorical propositions and the conclusion of the syllogism establishes the relation between the two categories represented by major term (predicate class of the conclusion) and minor term (subject class of the conclusion). This is done with the help of the middle term which is found in both the minor and the major premises but is unavailable in the conclusion. So there should not be any other term/class in a categorical syllogism. If there are more than three terms, then it is logically impossible to establish the conclusion about any two terms out of the given four terms using just three propositions. Hence, it becomes clear that if there are more than three terms, the argument fails to qualify as a categorical syllogism. A categorical syllogism should have at least and at most three terms, each occurring twice, spread across three propositions.

The fallacy that arises when this rule is faltered is called *Fallacy of four terms*.

Example:

All teachers are graduates.
Some graduates are sportsmen.
Therefore some teachers are athletes.

In this example, there are four terms, teachers, graduates, sportsmen and athletes. Hence the argument does not qualify to be a categorical syllogism despite the fact that all propositions used in the argument are in standard form. The information provided by the premises does not give us sufficient reason to assert the conclusion. Hence, the argument suffers from the fallacy of four terms.

12.2.1.2 Rule 2: Distribution of the middle term

A term is said to be distributed when it occurs in such a place in a proposition that the proposition refers to all the members of the class represented by that term, as it should be clear from the section on categorical propositions. This rule requires that the middle term must be distributed in either of its occurrence and it does not matter which. In other words, middle term must be distributed in the major or in the minor premise. As explained earlier, the middle term is the bridge that fills the gap between the major and the minor term and helps us assert a relation between the two in our conclusion. The major premise asserts the relationship between the major term and the middle term and the minor premise on the other hand asserts the relationship between the minor term and the middle term. So if the middle term is not distributed in either of these propositions then it means that no relationship has been established either by major term or by minor term with *all the members* of the class represented by middle term. This leaves out a vast unknown gap for us to be able to establish anything between major and minor term conclusively. Hence the conclusion cannot be said to have derived from the premises.

The fallacy which arises when this rule is faltered is called *Fallacy of undistributed middle*.

Example:

All horses are mammals.
All whales are mammals,
Therefore, all whales are horses

In the above example, the argument is a standard form categorical syllogism of form AAA-2. Since the middle term (mammals) is undistributed in both minor and major premises, the argument is invalid.

12.2.1.3 Rule 3: Any term distributed in the conclusion must be distributed in the premise

By now this would have become clear that the concept of distribution is important for applying these rules to test the validity of categorical syllogism by the Traditional method. As explained earlier, the conclusion establishes the relation between the classes represented by its subject and predicate terms, which are called in the discussion of syllogism, minor and major terms respectively. So if either of these terms is distributed in the conclusion, it means that the conclusion is referring to all the members of this class. And if this conclusion is to be followed from the premises, then that term must be distributed in the premise in which it has occurred before the conclusion. If the major term (predicate) of the conclusion is distributed, then the major term must be distributed in the major premise and the same applies in the case of minor term. However, this rule does not apply vice versa, that is to say if a term is distributed in the premises then it may not be a necessary condition for that term to be distributed in the conclusion. If one imagines the class, and if the relationship is known for all the members of that class, then it is logically possible for someone to assert something for some members of that class but it is not possible vice versa.

The fallacy that arises when this rule is not observed is called *Fallacy of Illicit Process*. There are two subclasses within the fallacy of illicit process, *illicit minor* and *illicit major* referring to the cases of minor term being distributed in the conclusion and not in the premise and the case of major term not being distributed in the conclusion and not in the premise, respectively.

Example:

All Sofas are Chairs
No Recliners are Sofas
Therefore, No Recliners are Chairs.

The argument is a standard form categorical syllogism (AEE-1). The predicate term of the conclusion, which is the major term (Chairs) is distributed in the conclusion, but is not distributed in the major premise. Hence the argument is invalid as it suffers from the fallacy of illicit major. Had it happened for the minor term, the fallacy would have been illicit minor.

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12.2.1.4 Rule 4: Avoidance of two negative premises

A negative proposition asserts the exclusion or non-inclusion of two classes or some parts of two classes. In other words, it establishes that some part of a class or the whole class is excluded from the other class and if both the premises of a categorical syllogism are negative in quality - that denies the inclusion of middle term with both minor and major term, and hence no relation can be established in the conclusion between major and the minor term, based on these premises. In other words, if both the premises assert exclusion, then they cannot base a conclusion asserting any kind of inclusion. Such a rule is very useful when it comes to test the validity of a given syllogism, as it becomes evident at the first instant itself if the given syllogism has two negative premises, and the given syllogism can be classified as invalid if it happens to have two negative premises and no further scrutiny is required there.

The fallacy that arises when this rule is faltered is called *Fallacy of exclusive premises*.

Example:

No cows are carnivores.
Some animals are not carnivores.
Therefore, some animals are not cows.

In this example, despite syllogism being in its standard form, we need not look any further for the validity or the invalidity of the argument. The argument suffers from the fallacy of exclusive premises and is invalid *prima facie* as it contains two negative premises.

12.2.1.5 Rule 5: An affirmative conclusion is not possible if one of the premises is negative

An affirmative conclusion asserts that minor and major terms are contained in each other, wholly or partially. However, such a conclusion requires the assertion from the major and the minor premises of the similar relationship between major and minor terms with middle term respectively. If either of the given premises does not provide such an inclusion, then the conclusion must not provide the inclusion either. That is to say, the conclusion cannot be affirmative if either of the premises is negative. This rule is another very easy rule to apply. As one can figure out in a given categorical syllogism prima facie whether the conclusion drawn from the premises is negative or affirmative, and if affirmative, is one of the given premise is negative.

The fallacy that arises when a syllogism does not follow this rule is called *Fallacy of drawing an affirmative conclusion from a negative premise*.

Example:

All cricketers are athletes
No athletes are drinkers
Therefore all drinkers are cricketers.

This argument is invalid in the very first observation as an affirmative conclusion is being drawn from a negative premise.

12.2.1.6 Rule 6: No particular conclusion may be drawn from two universal premises

As it would have been gathered from the section of categorical propositions that the universal propositions viz., A, E do not have existential import, but the particular propositions, viz., I, O have existential import. Applying Boolean analysis of categorical propositions, no conclusion that does not have existential import can be drawn from the premises that do have existential import. This rule is sometimes not included in the traditional account of categorical syllogism for the reason that traditional or Aristotelian logic does not concern itself with the problem of existential import. However, this rule is another useful tool to test the validity of a given categorical syllogism.

That fallacy that arises when this rule is flouted is called the *Existential fallacy*.

Example:

All vegetables are green
All spices are green
Therefore, some spices are vegetables.

In this argument, a particular conclusion is being drawn from universal premises hence the argument suffers from existential fallacy, and therefore, it is invalid.

Check Your Progress I

Note: (a) Use the space provided for your answer.

(b) Check your answers with those provided at the end of the unit.

1. Test the validity of the given syllogistic moods using the traditional six rules technique.

EAE-2, AII-2, AII-3, IAI-2, OAO-4, AOO-1

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12.2.2Venn Diagram Technique

Before we go into the method, let us recall how we represent categorical propositions in Venn Diagrams.

A: All S is P

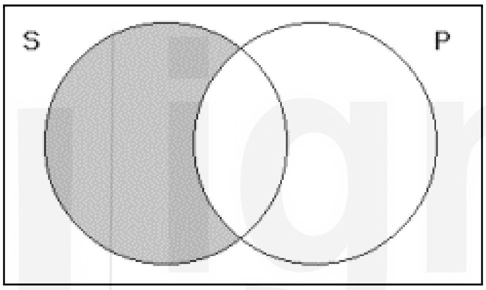

Figure 2.1

The shaded portion of S is an empty class, which is to say that every member of S is a member of P. Or in other words, there is no member of S which is not a member of P.

E: No S is P

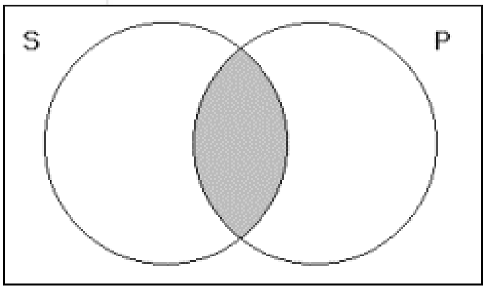

Figure 2.2

The shaded portion in between S and P again shows that there is no such member of either class which is also a member of the other class.

I: Some S is P

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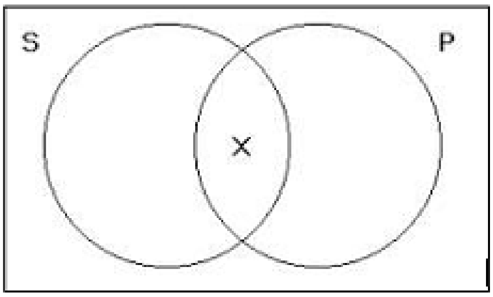

Figure 2.3

The portion where ‘x’ is written represents that there is at least one member of either class which is the member of the other class.

O: Some S is not P

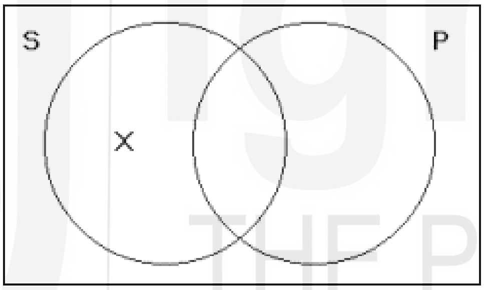

Figure 2.4

The position of ‘x’ represents that there is at least one member of the class S which is not a member of P.

One thing that should be noted here is that there are other ways to draw some of these propositions and that would not require us to shade some or the other portion, however, to maintain uniformity, it is advisable to draw two overlapping circles and then represent the given proposition by shading out some portion or inserting an X. For example, A can be drawn also as following (Figure 2.5)

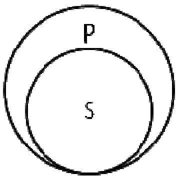

Figure 2.5

This Venn diagram represents the same fact which Figure-2.1 does, A, but we follow a uniform representation so that it's easier for us to visualise the differences between the different categorical syllogisms.

Now as we are clear about the Venn diagram for categorical propositions, we can move forward to testing the validity and invalidity of the categorical syllogism using Venn diagrams. The method involves following steps:

I. As it was mentioned in the introduction, it is required to convert a given categorical syllogism into standard form categorical syllogism, no matter whether the Aristotelian or Venn diagram technique is being followed so the first step would involve obtaining a standard form categorical syllogism.

II. The next step would require us to draw both the premises in a Venn diagram. The important thing to note here is that the two premises taken together contain three classes, viz., the classes represented by Major term (P), Minor term (S) and the Middle term (M). These three overlapping circles give rise to eight classes and the figure would look like the following (Figure 2.6):

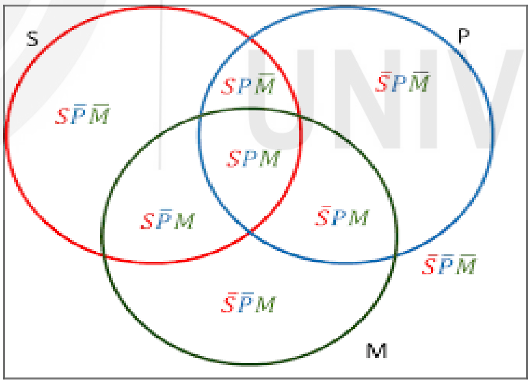

Figure 2.6

The classes being $S\bar{P}\bar{M}$, $SP\bar{M}$, $\bar{S}P\bar{M}$, $\bar{S}PM$, $\bar{S}\bar{P}M$, $S\bar{P}M$, SPM and $\bar{S}\bar{P}\bar{M}$.

III. After obtaining the Venn diagram representing both the premises, we are required to draw a Venn diagram representing the conclusion.

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IV. If both the diagrams (diagram obtained in step II and Step III) look exactly alike, or corroborate each other, then the given syllogism is a valid syllogism, else invalid.

The method will become clearer with an illustration:

Let's consider the example of syllogism of form AAA-1

So the syllogism will pan out as: All M is P
All S is M
Therefore, All S is P.

So to draw the first premise, we need to focus on the circles labelled as M and P, and shade out all the area of M which is not P. This shaded area will include both the regions $S\bar{P}M$ and $\bar{S}\bar{P}M$. In the next step, we will represent the second or Minor premise. To draw the minor premise, our focus should be on the circles named S and M, and we need to shade out all of S which is not M, and this shade will include both the area $SP\bar{M}$ and $S\bar{P}\bar{M}$. Once we have drawn both the premises, our diagram would look like the following one (Figure 2.7):

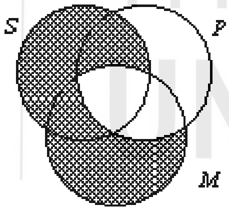

Figure 2.7

Now, a syllogism is considered valid if and only if the premises entail the conclusion and in the Venn diagram technique, this entailment is checked by testing whether after drawing the premises, the diagram obtained represents the conclusion or not. Now in the considered example, if one wishes to draw the conclusion, one need not shade out any portion or need not insert any X in the diagram obtained by the premises in order to represent the conclusion. In other words, if we were to draw the conclusion "All S is P", that would require us to shade out the portions

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labelled $S\bar{P}\bar{M}$ and $S\bar{P}M$, and as it is evident in the diagram that these two portions are already shade. Therefore, the considered syllogism is valid.

Let us consider another syllogism which we know to be invalid and see how we arrive at its invalidity using the Venn diagram technique. Let’s consider the syllogism of the form AAA-2.

So the syllogism will pan out as: All P is M
All S is M
Therefore, All S is P.

To draw the first or major premise, we will have to focus on the circles named P and M and we will shade out all of P which is not M, this shade will include both the portions $\bar{S}P\bar{M}$ and $SP\bar{M}$. similarly, when we draw the minor premise, we will shade out all the S which is not M. this shade will include $SP\bar{M}$ and $S\bar{P}\bar{M}$. The diagram that we will obtain after representing both the major and the minor premises would look like the following one (Figure 2.8):

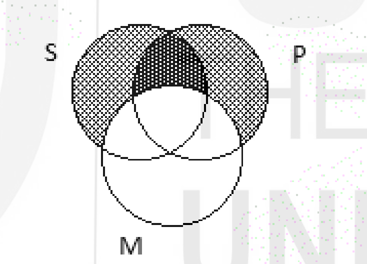

Figure 2.8

Now, does this diagram represent the conclusion? No. As it is evident that if we draw the conclusion “All S is P”, we will have to shade out $S\bar{P}M$ which is left unshaded in the diagram obtained by representing the premises. In other words, the conclusion asserts more than what has been asserted by two premises taken together and therefore the conclusion cannot be logically entailed by the premises, hence the considered categorical syllogism is invalid. Since, what we have proved is the invalidity of the form therefore any syllogism of the form AAA-1 will be valid and any syllogism of the form AAA-2 will be invalid.

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Both of the examples that we have considered above had only universal propositions as their premises, so it would not have mattered which premise is being drawn first, however, the sequence becomes very crucial if in a given syllogism one of the premises is of Universal quantity and the other is of Particular quantity. In that case, it is crucial to draw the diagram of Universal premise first before we draw the particular one. It is not pertinent to the matter which of these is minor or major. This sequence is followed so that we can become sure about inserting an element 'x' to represent the particular proposition. Let's consider an example of a syllogism which has one universal and one particular proposition as its premises, AII-3

So the syllogism will pan out as: All M is P

Some M is S

Therefore, Some S is P.

So, the first preposition that we will draw would be "All M is P" by shading out all of M that is not P. This shade will include $\bar{S}\bar{P}M$ and $S\bar{P}M$. Then when we draw the next proposition "Some M is S", we will have to insert an "x" in the intersection area of S and M, but that intersection is divided into two parts, $S\bar{P}M$ and SPM, and since we have already drawn the universal premise, and the class $S\bar{P}M$ is already shaded out, the "x" should come inside the unshaded part of the intersection, that is SPM. The Venn diagram thus obtained from the premises would look as following (Figure 2.9):

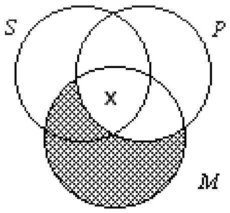

Figure 2.9

Now, once we have obtained the Venn diagram representing both the premises, we can analyse it by corroborating to the Venn diagram of the conclusion to see whether the syllogism is valid or invalid. If the conclusion asserting that "Some S is P" has already been drawn in this Venn

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diagram then there must be an ‘x’ somewhere in the intersection of S and P. this intersection part is consist of two sub parts $SP\overline{M}$ and SPM and an ‘x’ is there in the SPM region, therefore the given syllogism is valid.

Let’s consider one more example of the kind of syllogism in which the placing of ‘x’ to draw a particular proposition does not follow the kind of placement we did in the last example, AII-2.

The syllogism will pan out as: All P is M

Some S is M

Therefore, Some S is P.

As discussed in the last example, in order to draw the premises, we will start with the universal premise, “All P is M” in this case. We will shade out all of P which is not M; this shade will cover the classes $SP\overline{M}$ and $\overline{S}P\overline{M}$. When it comes to placing an ‘x’ to draw the particular proposition “Some S is M” in the Venn diagram, we still have both the regions SPM and $S\overline{P}M$ unshaded. So where do we place ‘x’? - on the line separating the two regions either of which can have ‘x’ but it is not clear in the syllogism. The reason why ‘x’ is placed on the line and not in either SPM or $S\overline{P}M$, is because the premises do not provide enough information for us to decide the class where ‘x’ should be placed. If we place ‘x’ arbitrarily in either of the two classes, the diagram would represent more information than that which is being provided by the premise. Therefore, it is very important to be cautious about what and how much is being asserted by the premises, if we do not want our Venn diagram technique to fail. So the Venn diagram obtained would look like the following figure (Figure 2.10):

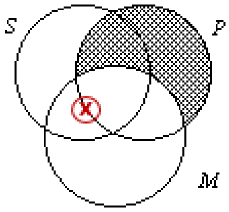

Figure 2.10

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Now, once the Venn diagram representing the assertion of both the premises have been obtained, we would go on to the next step to see whether the conclusion of the syllogism has already been drawn here, the conclusion "Some S is P" requires that the 'x' be placed neatly in the intersection of S and P, either in SPM or in SP$\bar{M}$. However, as it is clear that SP$\bar{M}$ has already been shaded out and contains no 'x' and the other region SPM may or may not have 'x' and we do not have enough information in the premises to place an 'x' in SPM, hence the syllogism is invalid. Another point that should be noted here is that the premises here do not give us enough information to claim that the conclusion *is* false. It may be false or may be true. All we know that the conclusion is not being *entailed* by the premises.

Check Your Progress II

Note: (a) Use the space provided for your answer.

(b) Check your answers with those provided at the end of the unit.

1. Test the validity of the given syllogistic moods using the Venn diagram technique.

EAE-2, AII-2, AII-3, IAI-2, OAO-4, AOO-1

12.3 FURTHER ON THE CATEGORICAL SYLLOGISM

There are four categorical propositions which can be used to give rise to any syllogism. Since a categorical syllogism involves three propositions, then there could be total 64 possibilities of different combination of categorical propositions (4^3=64, 4 being the number of categorical propositions and 3 being the number of propositions required for a syllogism). In other words, there can be 64 moods of categorical syllogism and since each of these mood can be found in any of the four figures, the total number of forms (mood and figure taken together) of categorical syllogisms possible are 256 (64*4=256). Out of these 256 forms of categorical syllogisms, only fifteen forms are Valid. Since the number of forms that are valid is relatively less, each of these fifteen forms has been given unique names which are as follows:

i.	AAA-1	Barbara
ii.	EAE-1	Celarent
iii.	AII-1	Darii
iv.	EIO-1	Ferio
v.	AEE-2	Camestres
vi.	EAE-2	Cesare
vii.	AOO-2	Baroko
viii.	EIO-2	Festino
ix.	AII-3	Datisi
x.	IAI-3	Disamis
xi.	EIO-3	Ferison
xii.	OAO-3	Bokardo
xiii.	AEE-4	Camenes
xiv.	IAI-4	Dimaris
xv.	EIO-4	Fresison

It is neither important nor required to remember the names of these valid forms. As long as one remembers the basic six rules of categorical syllogism, making a distinction between valid and invalid syllogisms can be carried out easily.

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12.4 LET US SUM UP

One of the many purposes of logic itself is to distinguish valid arguments from invalid ones. Categorical Syllogisms are different from other kinds of arguments because of their formal nature. The formal nature of the syllogisms enables us to analyse these solely on the basis of their form. Since, the analysis at the formal level is completely devoid of the content; we saw in this unit that this provides us an opportunity to use abstract mathematical method of Venn diagrams to test the validity of syllogisms. The use of Venn diagrams brings out the relation between the set theory and logic. The unit provided the Aristotelian (the Classical) technique of testing categorical syllogism and Venn diagram technique.

12.5 FURTHER READINGS AND REFERENCES

- Copi, I.M. *Introduction to Logic*. New Delhi: Prentice Hall India, 9th Ed., 1995.
- Copi, I. M., and Carl Cohen. *Essentials of Logic*. 2nd ed. Upper Saddle River, N.J.: Pearson Prentice Hall, 2007.

12.6 ANSWERS FOR CHECK YOUR PROGRESS

Check Your Progress I and II (Please use the traditional and Venn diagram techniques to find the validity and invalidity)

EAE-2	valid
AII-2	invalid
AII-3	valid
IAI-2	invalid
OAO-4	invalid
AOO-1	invalid

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UNIT 13 NON-CATEGORICAL SYLLOGISM[*]

Structure

13.0 Objectives

13.1 Introduction

13.2 Disjunctive Syllogism

13.3 Hypothetical Syllogism

13.4 Dilemma

13.5 Let Us Sum Up

13.6. Key words

13.7 Further Readings and References

13.8 Answers to Check Your Progress

13.0 OBJECTIVES

The objectives of this unit are,

- to introduce the non-categorical syllogisms.
- to elaborate two major kinds of non-categorical syllogisms, namely: disjunctive syllogism and hypothetical syllogism.
- to discuss another kind of non categorical argument called dilemma, which is very commonly used in everyday life and the different types of dilemmas and how they can be tackled.
- to enable the learners to distinguish logically sound dilemmas from those which are not sound or acceptable.

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13.1 INTRODUCTION

A proposition is classified as a categorical proposition when it establishes the relation between the two categories or classes. The relation can be of exclusion (negative proposition) or of inclusion (affirmative propositions). A syllogism is called categorical syllogism when it is constituted of categorical propositions. However, there are propositions which are not categorical and the syllogisms formed by these propositions are named as per the propositions they are made of. As discussed in the earlier unit, an argument is classified as a syllogism when it has three propositions of which two serve as premises and the third one as conclusion*. Since the discussion is about non-categorical syllogisms (syllogism being the key word here), we will still be dealing with the arguments with three propositions. The important distinction between the categorical and non-categorical is that in the latter case, at least one of the propositions must not be a categorical proposition or all of them may not be categorical.

Example:

Either the global warming is correct or earth's temperature would not rise.
Earth's temperature is rising.
Therefore, Global warming is correct.

The syllogism given above is of compound nature. If we follow the modern logicians' nomenclature, the term non-categorical syllogism becomes contradictory. For them a syllogism has to be categorical, and if it is not categorical then it is not syllogistic in nature. But for traditional logicians, any argument with two premises and a conclusion is syllogistic in nature and then they are classified into categorical and non-categorical depending upon the kind of propositions they contain. There are two most prominent non-categorical syllogisms. They are also called compound syllogisms.

1- Disjunctive syllogism
2- Hypothetical Syllogism

13.2 DISJUNCTIVE SYLLOGISM

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*This distinction was maintained by the classical or Aristotelian logicians. For modern logicians starting from Boole, an argument is syllogistic only when it is a categorical syllogism. This is the reason that in the modern logic, terms 'syllogism' and 'categorical syllogism' are used interchangeably.

As mentioned earlier, the syllogisms are named in accordance to the kind of propositions they contain. A categorical syllogism is named so for the reason that it contains propositions which are in standard form or categorical. A disjunctive syllogism contains a disjunctive proposition. Disjunctive propositions are also called Alternative propositions. An example of disjunctive proposition is "Rama is either a very intelligent person or a very lazy one". The two parts of this disjunctive proposition are simple propositions, namely, "Rama is a very intelligent person" and "Rama is a very lazy person". The components of a disjunctive proposition are called *disjuncts*. A disjunctive proposition does not assert the truth or falsity of any of its disjunct conclusively. The implication that one can draw from a disjunctive proposition is that either one of the two components is true. This leaves the possibility open for both the disjuncts to be true.

If in a given syllogism, one of the premises is a disjunctive proposition and the other proposition of the syllogism is a denial of either of the disjunct of the first premise, then we can conclusively assert the truth of the second disjunct in the conclusion. Such disjunctive syllogisms are valid disjunctive syllogisms.

Example: Either Virat was injured or he was not selected for the team.
Virat was selected for the team.
Therefore, Virat was injured.

In the considered disjunctive syllogism, the two disjuncts of the first premise are, "Virat was injured." and "Virat was not selected for the team". The second premise of the given syllogism, "Virat was selected for the team" denies the second disjunct, and the conclusion asserts the other disjunct, hence the given disjunctive syllogism is valid.

A disjunctive syllogism can be stated symbolically in either of the two forms given as follows

i. Either p or q
$\sim p$
Therefore, q

ii. Either p or q
$\sim q$
Therefore, p

So in other words, a disjunctive proposition is valid when it follows the following three conditions:

i. The first of the two premises is a disjunctive proposition. (In fact, either of the two premises could be a disjunctive proposition, the order of first and second is primarily to visualise the assertion of argument.)
ii. The next premise is a negation of or is in contradiction to, either of the two disjuncts of the first disjunctive proposition.
iii. The conclusion asserts the remaining disjunct of the disjunctive proposition considered in the first step.

In the example that we had considered before laying out these rules, all the three conditions were being fulfilled. Therefore, the given disjunctive syllogism was classified as a valid disjunctive syllogism.

If we are classifying a category of valid categorical syllogisms, then *ipso facto*, there should be another category which needs some discussion, the category of invalid disjunctive syllogisms. Let's consider the following disjunctive syllogism,

Either X institute is very expensive or it is very good.
X institute is very good
Therefore, X institute is not very expensive.

If we write the above argument in the symbolic form, we will get the following,

Either p or q
p
Therefore $\sim q$

If we look closely at the argument given above, we find that the conclusion does not necessarily follow from the premises. Even if we assume that both the premises of these disjunctive syllogisms are true, there is no implication of the conclusion. It is possible that the institute X is very good and at the same time it is very expensive. In other words, the truth of either of the two disjuncts of the given disjunctive proposition doesn't imply the falsity of the other disjunct. Both of the disjuncts can be true together. If we can recall the relationships which were discussed in traditional square of opposition, we can claim that the two disjuncts share the relationship of the contrariety and not of contradiction. The truth of one does not entail the falsity of the other. Both can be true together but cannot be false together. So the disjunctive syllogism of the form mentioned above is invalid. The conditions of the invalidity of the disjunctive syllogisms can be summarised as follows:

1. The first premise is a disjunctive syllogism.
2. The second premise affirms one of the two disjuncts of the first premise.
3. The conclusion denies the other disjunct of the disjunctive proposition given in the first step.

In symbolic form, an invalid disjunctive syllogism can have either of the two following forms:

i. Either *p* or *q*
p
Therefore, ~*q*

ii. Either *p* or *q*
q
Therefore, ~*p*

It is clear from the discussion above that a disjunctive syllogism is valid only when the second premise *contradicts* one of the two disjuncts contained in the disjunctive proposition, and the conclusion asserts the other disjunct. Cases where the categorical premise is simply asserting one of the disjuncts of the disjunctive premise, and conclusion is denying the other disjunct, the disjunctive syllogisms in those cases would be invalid.

13.3 HYPOTHETICAL SYLLOGISM

Another non categorical syllogism that is often used and discussed in reasoning is Hypothetical syllogism. Any syllogism which has one or more than one hypothetical propositions is classified as hypothetical syllogism. Hypothetical proposition is another compound proposition. It is also known as conditional proposition. An example of hypothetical proposition could be, “If it rains then the match will be cancelled”. This hypothetical proposition contains two propositions, one which is followed by ‘if’ and preceded by ‘then’, the other followed by ‘then’. The first component proposition is called *antecedent* and the second component which is followed by ‘then’ is called *consequent*. The two components of a hypothetical proposition are always related by “If-then” relationship.

Hypothetical syllogisms are divided into two kinds, depending on the kinds of propositions they contain. If all the propositions in a given hypothetical syllogism are hypothetical, then the syllogism will be classified as pure hypothetical syllogism. If there is at least one of the propositions in a hypothetical syllogism is categorical, then the given syllogism will be classified as mixed hypothetical syllogism.

13.3.1 Pure Hypothetical Syllogism

let's start by considering an example-

If Shyam is regular in his studies, then he gets good grades.
If he gets good grades, then he has a better job prospect.
Therefore, if Shyam is regular in his studies, then he has a better job prospect.

In the above example, all the three propositions involved are hypothetical or conditional in nature; therefore it is a case of pure hypothetical syllogism. On closer observation, we can see that the antecedent of the first premise is same as that of the conclusion and the consequent of the second premise is same as that of the conclusion. This setup of component parts makes this hypothetical syllogism a valid syllogism. In general terms, only that pure hypothetical syllogism is valid in which the antecedent of the conclusion is shared by one of the premises and the consequent of the conclusion is shared by the other remaining premise. In addition to this, consequent of the premise (which shares its antecedent with the conclusion) must be shared by the antecedent of the other premise (which shares its consequent with the conclusion). In symbolic representation, a valid pure hypothetical syllogism can be represented in either of the two following ways:

i. If p, then q
If q, then r
Therefore, if p, then r

ii. If q, then r
If p, then q
Therefore, if p, then r

These are the only two ways in which valid pure hypothetical syllogisms can be expressed. Following are the ways in which pure hypothetical syllogisms will be invalid-

i. If p, then q
If q, then r
Therefore, if r, then p

ii. If q, then r
If p, then q
Therefore, if r, then p

iii. If p, then q
If r, then q
Therefore, if p, then r

iv. If p, then q
If p, then r
Therefore, if q, then r

13.3.2 Mixed Hypothetical Syllogism

In a mixed hypothetical syllogism, there is only one hypothetical proposition as premise, and the other premise and the conclusion is categorical in nature. Let’s consider an example

If it snows, then the roads will be blocked.

It is snowing.

Therefore, the roads will be blocked.

In the above example, the first premise is a hypothetical proposition and that is the only hypothetical proposition here, hence the considered syllogism is hypothetical syllogism. The second premise is same as the antecedent of the first premise and the conclusion is same as the consequent of the first premise. This is a valid hypothetical syllogism. There is another form in which mixed hypothetical syllogism can be expressed validly. Let’s take another example,

If it snows, then the roads will be blocked.

Roads are not blocked.

Therefore, it did not snow.

In the above example, the first proposition is the same disjunctive proposition, however, the second premise here is the negation of the consequent of the first premise and the conclusion in this case is the negation of the antecedent of the first hypothetical premise. This is another valid form for mixed hypothetical syllogism. Symbolically, these two valid forms can be expressed as follows,

i. If p, then q
p
Therefore, q

ii. If p, then q
~q
Therefore, ~p

The rules of inferences involved in these valid mixed hypothetical syllogisms are *Modus Ponens* and *Modus Tollens*, respectively. The literal meaning of the phrase "Modus Ponens" is "the mode that affirms by affirming". In the first form, we can see that the conclusion is being affirmed by the assertion of the antecedent of the hypothetical proposition. "Modus Tollens", on the other hand, means "the mode that denies by denying". It is again evident in the second case that the antecedent of the hypothetical proposition is being denied in the conclusion based on the denial of the consequent of the hypothetical proposition.

It is important to understand here, that these two valid forms can often be confused with the invalid ones, as they appear similar. The invalid forms of mixed hypothetical syllogism are as follows,

i. If p, then q
~p
Therefore, ~q (fallacy of denying the antecedent)

ii. If p, then q
q

Therefore, p (fallacy of affirming the consequent)

The first one looks like Modus Tollens but differs from it because of the fact that the antecedent is being denied in the second premise, instead of the consequent and the negation of consequent is being affirmed in the conclusion. This fallacy is called the fallacy of denying the antecedent.

The second one above looks like Modus Ponens but differs from it for the reason that the consequent is being affirmed in the second premise instead of the antecedent. This fallacy is called fallacy of affirming the consequent.

Check Your Progress I

Note: (a) Use the space provided for your answer.

(b) Check your answers with those provided at the end of the unit.

Identify the kind of non categorical syllogism in the following arguments (1-3) and check their validity.

1. Either India does not have enough economic resources or Indian citizens are not willing to change their standards of living.

India does have enough economic resources.
Therefore, Indian citizens are not willing to change their standard of living.

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1. Either Shyam goes for shopping very frequently or he receives a lot of gifts from his friends.
   Shyam does not go for shopping very frequently.
   Therefore, he does not receive a lot of gifts from his friends.

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2. If the weather is nice today then we shall go for outing.
   The weather is nice.
   Therefore, we shall go for outing.

Choose the right conclusion for the given Hypothetical Syllogism among the two alternatives so that the syllogism remains valid:

4. If Indian team plays well, then it will win against other team.

If Indian team wins against other teams then it will win the world cup.

i. Therefore, if Indian team wins the world cup, then it plays well.
ii. Therefore, if Indian team plays well then it wins the world cup.

13.4 THE DILEMMA

The dilemma is altogether a different kind of argument as compared to the arguments we have discussed so far. Dilemma is commonly used in ordinary language during debates and discussions. Almost all of us must have heard people using the word dilemma to describe their day to day confusion to decide things. People are often heard saying that they are in a serious

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dilemma when they are indecisive about choosing one among two equally unpleasant alternatives. Hence, dilemma can be better understood as a rhetoric device employed by debaters to counter or ridicule their opponents' positions. This rhetoric device makes use of different syllogisms and syllogisms used are often ordinary syllogism from the perspective of logic. Because of the use of these ordinary syllogisms, dilemma does not have much importance if evaluated from a strict logical point of you. Dilemma, nonetheless, is considered one of the very lethal and effective techniques of persuasion. If one uses the technique correctly, one can force one's opponent in a corner to make him choose from the given alternatives, both of which would be contradictory or often at least unpleasant to him. It happens more than often, yet dilemma need not always have unpleasant alternatives to chose from. From the view point of logic, and the reason why dilemma is often categorised as one of the non-categorical syllogisms, is that a dilemma can be presented in a standard form to have three propositions, out of which two serve as premises for the third one which will serve as the conclusion. All the three propositions used in a dilemma are compound propositions. One of the two premises is often a conjunction of two hypothetical propositions; the other premise is often a disjunctive proposition. The conclusion drawn from these will often be a disjunctive proposition, presenting the two alternatives to chose from. The two alternatives provided in the conclusion of a dilemma are known as two horns of the dilemma.

There could be two valid forms of inference in which a dilemma can be put, Constructive Dilemma and Destructive Dilemma. The symbolic representation of the two is given as follows-

- **Constructive Dilemma**
  (If p then q) and (if r then s)
  Either p or r
  Therefore, q or s
  In propositional logic, the same can be presented as:

$$(p \supset q) * (r \supset s)$$

$$p \vee r$$

$$\therefore q \vee s$$

- **Destructive Dilemma**

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(If p then q) and (if r then s)
Either not q or not s
Therefore, either not p or not r
In propositional logic, the same can be presented as:

$(p \supset q) * (r \supset s)$
$\sim q \lor \sim s$
$\therefore \sim p \lor \sim r$

There are two ways one can deal with a given dilemma, one is logical approach and the other one is informal one. The two approaches are as follows,

13.4.1 Refutation of Dilemma

This is a logical approach to deal with a dilemma. In this approach the attempt is made to prove the dilemma to be invalid or unsound. The *modus operandi* of this approach is to attack either of the premises. If it can be shown that, in the premise containing the disjunctive propositions, both of the given disjuncts are false, and then the proposition itself will be false. (Recall, false ∨ false = false). This would make the conclusion undetermined and the argument, invalid. Because the conclusion is asserted on the assumption that either of the disjuncts presented in this premise is true.

Refutation of a dilemma is difficult than it seems to be, and since as mentioned earlier, the device of dilemma is often used in rhetoric, the informal methods take precedence over the formal one.

13.4.2 Rebuttal of Dilemma

This approach is an informal approach and the purpose here is not to prove dilemma invalid but to find the ways in which *one can try to avoid the conclusion of the dilemma* presented to him, without challenging the formal validity of the dilemma. Rebuttal is often done in three ways, which are discussed as follows:

13.4.2.1 Rebuttal by posing a counter dilemma:

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This is the most lethal of the ways to defeat one's opponent in the debates. When presented by a dilemma, one could posit a counter dilemma (often with at least one same premise) without even discussing the alternatives presented, and arriving at a different alternative. A very famous example that highlights the rebuttal by positing a counter dilemma comes from a classical anecdote of Athens, where a mother is trying to persuade her son to not enter into politics. The dilemma presented by mother goes as,

"If you say what is just, men will hate you; and if you say what is unjust, the gods will hate you; but you must either say the one or the other; therefore you will be hated."

The son countered the dilemma presented to him by his mother, by presenting a counter dilemma using one of the premises used by his mother. The counter dilemma goes as,

"If I say what is just, the gods will love me; and if I say what is unjust, men will love me. I must say either the one or the other. Therefore I shall be loved!"

Such rebuttals are considered to be come from those who have a great rhetorical skill.

13.4.2.2 Escaping between the horns

As the name suggests, this technique works by trying to avoid both the horns of a dilemma. The strength of dilemma lies in the fact that the two alternative options presented in the conclusion are taken to be the *only* two possible alternatives that can be derived from the given premises. So if one tries to negate this possibility of there being only two possible alternative, the approach is called escaping between the horns.

Let's consider the following example that will make it clear,

If Ram is a hard working employee, then he needs no incentives and if he is lazy then no incentive will motivate him.

An employee is either hard working or lazy.

Therefore, incentives are either needless or useless.

The disjunctive proposition claims that there are only two alternatives possible, that every employee is either lazy or hardworking, but this is a wrong assumption. There could be many employees who are neither exceptionally hard working nor lazy, rather who do as much asked or required. These employees can be motivated if they are given incentives. Once this false dichotomy is exposed, it will show that the alternatives presented in the conclusion are not the only alternatives. This has been achieved by showing the minor premise to be false. This is an instance of escaping between the horns.

13.4.2.3 Taking the Dilemma by the horns (grasped by the horns)

In the last case, we saw that if the minor premise was proved to be false, it made the dilemma false. However, if the given minor premise is a tautology then it is not possible to escape the dilemma 'between the horns' as there are no means available to us to expose the false dichotomy. In such cases, we need a different strategy to refute the given dilemma. We start by observing the major premise, and as explained earlier the major premise is a conjunction of two hypothetical propositions. Major premise is of the form $(p \supset q) * (r \supset s)$ that means p implies q and r implies s, and if we could show either that q does not follow consequently from p or s does not follow from r, then it will prove the dilemma to be unsound. This approach for the rebuttal of dilemma is called taking the dilemma by the horns or grasping the dilemma by the horns. Consider the following example:

If pregnant women have the freedom of choice, then pregnancy awareness programs should not be conducted and if pregnant women do not have the freedom of choice then pregnancy awareness programs are useless.

Either pregnant women have freedom of choice or they do not have freedom of choice.

Therefore, either the awareness programs should not be conducted or they are useless.

Now in the given example, the minor premise is a tautology (recall that a disjunctive proposition of the form $p \vee \sim p$ will always be true) so it is not possible to escape between horns. However, if we look closely at the major premise, the consequents, "pregnancy awareness programs should not be conducted" and "pregnancy awareness programs are useless" are not being followed from their consequents, "pregnant women have the freedom of choice" and "pregnant women do not have the freedom of choice". In the first hypothetical proposition, if the pregnant women have the freedom of choice then it becomes more important to conduct pregnancy awareness programs so that they can make informed choice, hence the consequent is not being followed from the antecedent. In the second hypothetical statement, if the women do not have the freedom of choice does not imply that they should not be made aware about pregnancy. Hence the dilemma becomes unsound.

Check Your Progress II

Note: (a) Use the space provided for your answer.

(b) Check your answers with those provided at the end of the unit.

1. Write the conclusion for the incomplete Dilemma given and then state which technique can be applied for its rebuttal:
   If I go abroad for post doctoral research immediately after my PhD, then I may lose job opportunity here in the country and if I stay here in the country, then I may not get good Post Doc position later.
   Either I go abroad for post doctoral research immediately after my PhD or I stay here in the country.

13.5 LET US SUM UP

In this unit we have discussed two major kinds of non-categorical syllogisms, namely: disjunctive syllogism and hypothetical syllogism, dilemma and its different types. We have also discussed how dilemma can be resolved. Dilemma can be tackled either by refute it or by rebut it. In our everyday life we face so many dilemmas, if we do not pay attention to these dilemmas; we may find ourselves in an unwanted situation. That is why the study of dilemma and the techniques to resolve them or tackle them is very important.

13.6 KEY WORDS

Dilemma: Dilemma is a rhetoric device in which the conclusion is a disjunctive proposition containing two equally unpleasant alternatives.

Disjunctive Syllogism: A disjunctive syllogism is an example of non-categorical syllogism which contains at least one and at most one disjunctive proposition, and one simple proposition which denies either of the disjuncts of the disjunctive proposition.

Hypothetical Syllogism: A hypothetical syllogism is another example of non-categorical syllogism which contains at least one hypothetical proposition. All the proposition may be hypothetical in nature.

Non-Categorical Syllogism: A non-categorical syllogism is a syllogism which has at least one non-categorical proposition.

13.7 FURTHER READINGS AND REFERENCES

- Copi, I. M., and Carl Cohen. *Essentials of Logic*. 2nd ed. Upper Saddle River, N.J.: Pearson Prentice Hall, 2007.
- Jain, Krishna. *A Textbook of Logic*. 5th ed. D.K. Printworld New Delhi, 2018.

13.8 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress I

1. Disjunctive syllogism, valid
2. Disjunctive syllogism, invalid
3. Mixed hypothetical syllogism, valid
4. (ii)

Check Your Progress II

1. Conclusion: Either I may lose job opportunity here in the country or I may not get good Post Doc position later.

UNIT 14 PROPOSITIONAL LOGIC[*]

Structure

14.0 Objectives
14.1 Introduction
14.2 Propositions and Symbolization
14.3 Well-Formed Formulas
14.4 Truth Functions
14.5 Truth-Table for propositions
14.6 Tautology, Self-Contradictory and Contingent Propositions
14.7 Truth-table for arguments
14.8 Indirect Truth Table Method
14.9 Argument Forms
14.10 A brief note on Formal Proof of Validity
14.11 A Note on Indian Logic
14.12 Let us Sum Up
14.13 Key Words
14.14 Further Readings and References
14.15 Answers to Check Your Progress

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14.0 OBJECTIVES

The objective of this unit is to introduce learner to Propositional Logic. Understanding Propositional Logic is crucial for understanding the development of Modern Logic or Symbolic Logic. It also helps learner to understand the techniques used by Propositional Logic to test the truth and validity in Logical expressions. Through the analysis of different aspects of Propositional Logic, learner shall be able to learn:

- the nature of Propositional Logic
- the process of symbolization in Propositional Logic

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- the types of Truth-Functional Proposition
- the use of Truth-Table method
- Indirect Truth Table Method
- Parallels of Propositional logic in Indian Logic

14.1 INTRODUCTION

In the previous Blocks of this Course and in the previous Units of this Block you have learnt that the validity of deductive argument depends on its form. This has been made more clear in the Units on Syllogism. By simply looking at the form you can say whether an argument is valid or invalid. You may have however noticed that the assessment of the form is complicated due to the ordinary use of language. For example, same term can be used in two propositions signifying different meaning, or sometimes the relation between two terms may not be clearly stated. Logicians therefore have been always trying to simplify the process. In Traditional Logic you have seen how the letters S, P, and M are used to represent the terms in Syllogistic Arguments and how a Syllogism was given a Standard Form. This was to some extent able to reduce the obscurity of ordinary language. However, this process was largely limited to two things: using only Categorical Prepositions in Standard Form Syllogism, and symbolization of the terms of propositions. But Modern Logicians went to further extent to make the recognition of logical forms easier by use of special symbols that represent the relation between terms as well. They made efforts to re-classify propositions so that even the form of arguments with complex propositions can also be easily recognized. These efforts led to the development of Propositional Logic.

Unlike Traditional Logic, Propositional Logic, while dealing with arguments, considers the whole proposition and not concerned with the terms of the proposition. Since it deals with Propositions or logical sentences, it is known as Propositional Logic and sometimes it is also called Sentential Logic. Propositional Logic thus does not analyze the internal structure of the proposition (There is however another branch of Modern Logic which analyses the internal structure of propositions. That branch of Logic is known as Predicate Logic. We have no scope to discuss it here) Propositional Logic deals with the whole propositions of an arguments. The propositions are represented by letters and the relationships between propositions are represented by Connectives or operators. Thus Propositional Logic can represent complex arguments in a symbolic form and determining the validity of such arguments become very easy.

14.2 PROPOSITION AND SYMBOLIZATION

Propositional Logic deals with arguments containing propositions and in consideration of the argument for validity and invalidity each proposition is considered as a whole. So it cannot rely on the traditional definition and classification of proposition. Traditional Logic, as you have already seen, was largely confined to categorical propositions. Thus traditional logic was unable to deal with arguments containing complex sentences. Propositional Logic overcomes these limitations by accepting the modern definition of proposition as a statement that is either true or false. So it is not limited to sentences with two terms and a copula.

Modern logicians have broadly categorized propositions into two types- Simple and Compound Propositions. Propositional Logic relies on this categorization. This distinction is significant to understand the symbolization process of argument and testing their validity in propositional logic.

A Simple Proposition is a proposition that does not contain any other proposition as it's component. In other words, a simple proposition can not to be divided into different propositions. For example:

Tansen was a great musician.
Yoga was invented in ancient India.
Tagore was a Nobel laureate.

These propositions do not have other propositions as components. Therefore, these are Simple Propositions. In propositional logic these propositions are symbolically represented using any convenient uppercase letter. Usually the first letter of any significant word may be taken. Here *T*, *Y*, *T* can be used to represent the above three propositions respectively. Now you can see that *T* is used twice taking a clue from the words "Tansen" and "Tagore". Don't you think this would create confusion in certain cases? It will. Especially if these are parts of the same argument. So, for all simple propositions of one argument we need to use unique uppercase letter for each propositions. We shall come back soon on this topic of symbolization. Let us first know about compound proposition now.

A **Compound Proposition** can be defined as a proposition containing one or more simple propositions as component. For example,

It is not the case that Tansen was a great musician.

Yoga was invented in ancient India and Tagore was a Nobel laureate.

In the first case there is one simple proposition as component that is "Tansen was a great musician". And in the second proposition there are two simple propositions as components - (1) Yoga was invented in ancient India, (2) Tagore was a Nobel laureate.

Logicians broadly categorizes Compound Propositions in to five types: Negation, Conjunction, Disjunction, Conditional and Bi-Conditional

Negation or a Negative Proposition contains the negation of a proposition. In this proposition the word "not" or the phrase "It is not the case that" is used. For instance, "Harish is not an honest person", "It is not the case that Harish is a honest person.' Please note that merely using a word with negative connotation does not make a proposition a negative compound proposition. "Harish is a dishonest person" for example, is just a simple proposition, "Harish is not a dishonest person" is a negation, and therefore, a compound proposition.

Conjunction or Conjunctive Proposition is a compound proposition where simple propositions are connected by the word "and" or its equivalent. For example, "Rama is a teacher and Dinesh is a journalist". The proposition contains two simple propositions- "Rama is a teacher" and "Dinesh is a journalist". These component propositions are called conjuncts.

Disjunction or Disjunctive Proposition is a compound proposition where simple propositions are connected by the word "and" or its equivalent. For example, "Rama is a teacher or Rama is a journalist". The proposition contains two simple propositions- "Rama is a teacher" and "Rama is a journalist". These component propositions are called disjuncts. It may be noted that disjunctive proposition can further be divided into exclusive and inclusive Disjunctions. In exclusive disjunctions only one of the two disjuncts can be true. For

Conditional Proposition is a compound proposition where the relation between the components is expressed by "if" and "then". For example, if the weather is unsuitable then the cricket match will be cancelled. In this compound proposition the two simple propositions namely “the weather is unsuitable” and “the cricket match will be cancelled” are connected by” if…then..”. The proposition followed by “if” is called antecedent and the proposition followed by “then” iscalled consequent. The relation is called a material implication. Because the material truth of the consequent is implied or conditioned by the material truth of the antecedent. Please note here that implication should not be taken in a sense of derivation like when the proposition of an argument implies the conclusion.

Biconditional proposition, on the other hand, is a compound proposition where the components are connected by the phrase “if and only if”. For example, Seema will go to Cinema if and only if Rihana goes with her. Here the relation is of material equivalence. This proposition is called bi-conditional because it contains a combination of two conditional propositions. If we analyze the present example, we find the following- Seema will go to Cinema if Rihana goes with her and Seema will go to Cinema only if Rihana goes with her. The relation between the components here is a necessary and sufficient condition.

Now let see how these five types of Compound Propositions can be symbolized following the method sated above.

Compound Proposition	Example	Symbolization
Negative Proposition	It is not the case that Harish is a honest person	It is not the case that H
Conjunctive Proposition	Rama is a teacher and Dinesh is a journalist	R and D
Disjunctive Proposition	Rama is a teacher or Rama is a journalist	T or J
Conditional Proposition	If the weather is unsuitable then the cricket match will be cancelled	If W then C
Biconditional Proposition	Seema will go to Cinema if and only if Rihana goes with her	S if and only if R

Table 1: Compound Proposition and Symbolization

Here you can see that the simple propositions from each compound propositions is symbolized using an upper case alphabet. But how to symbolize the words and phrases like “it is not the case that “or”, “and”, “if ...then…”,, “if and only if”? Now before going to symbolize these we need to remember these are unlike simple propositions. These expressions reveal the nature of a compound proposition. In case of Negation, it negates a simple proposition, in case of others there are at least two simple propositions connected in a particular way with a particular meaning. Therefore, while symbolizing the compound prepositions we need to use special logical symbols which are known as Logical Operators or connectives or logical constants. These help us in translating English sentences into symbolic logical expressions. Thus we have five logical operators to express compound propositions. The following list is going to be our guide in the process of symbolization.

Proposition	Representing Words/Phrase	Logical Operator to be used	Name	Function
Negative Proposition	Not/it is not the case that/it is false that/	~	Tilde	Negation
Conjunctive Proposition	And/also/moreover	•	Dot	Conjunction
Disjunctive Proposition	Or/unless	V	Wedge	Disjunction
Conditional Proposition	Only if/if..then..	⊃	horseshoe	Implication
Biconditional Proposition	If and only if/is a sufficient and necessary condition for	≡	Triple bar	Equivalence

Table 2

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In the light of the above list, let us symbolize the previous list of examples using operators.

Compound Proposition	Example	Symbolization	Symbolization Using Operator
Negative Proposition	It is not the case that Harish is a honest person	It is not the case that H	**~H**
Conjunctive Proposition	Rama is a teacher and Dinesh is a journalist	R and D	R •D
Disjunctive Proposition	Rama is a teacher or Rama is a journalist	T or J	T v J
Conditional Proposition	If the weather is unsuitable then the cricket match will be cancelled	If W then C	W ⊃ C
Biconditional Proposition	Seema will go to Cinema if and only if Rihana goes with her	S if and only if R	S ≡ R

Table 3

In general, this is the process of symbolization. This is the way we can “translate” sentences into logical proposition in symbolic form making it easy to decide the logical structure of a compound proposition. But this “translation” may not always capturefull sense of ordinary language, but it is able to do so to a great extent. However, we do not have scope to discuss that issue here. Now let us discuss some more examples to familiarize with the symbolization process.

As we have noted earlier any negated proposition is a compound proposition with negation of a simple proposition. So we can always use the tilde sign to represent such proposition. The negation can be expressed in various ways in ordinary language but the use of logical operator remains similar in each cases.

All humans are not scientist	~ S
It is not the case that all humans are scientist	~S
It is false that all humans are scientist	~S

So it appears that tilde needs to be placed before a proposition. It cannot be placed as a connector of two propositions. Thus the expression S~ is not proper. Similarly, S~P is also not correct. However, S • ~P is correct because here tilde is placed before P. Here you can see that tilde can be placed after another operator. We can use tilde before a compound proposition including multiple simple propositions also. But it must stand to mean as a negation of what followed by the tilde. For example

~(PvQ)
~(P•.(Q≡R))
~[(P•S) v (Q⊃R)]

All these propositions are negative propositions, because in these expression *tilde* is the main operator. But what is a **main operator**? The main operator is that operator under the scope of which everything else of a compound proposition is included. As you know in a compound proposition there could be one or more simple proposition. So when there are more component propositions in a compound proposition then there may be many operators as well. But the statement can be expressed properly only when we know the main operator that will signify the main proposition. Take for example: A •B **v** C. Here we are not sure what type of compound proposition this is. Because the main operator is not identified. Let us restate the proposition with a main operator: A • (B **v** C). Here dot (•)is the main operator because everything is within its scope, while the scope of wedge (v) is limited to B and C only. One easy way to identify the main operator is that if there are parentheses, brackets or braces, whatever is outside those is the main operator. In such cases if there are two operators then whatever is not tilde is the main operator. For example: (H v H) • ~ (P v Z). Here dot is the main operator.

Now let us check Conjunction. The dot symbol (•) is used to translate such conjunctions as "and," "also," "but", "however," "yet," "still," etc. While translating such propositions we need to make sure that the logical statement is equivalent to the ordinary sentence. For example- Rama and Laxmana are philosopher. This can be translated as R • L because the sentence stands for Rama is a philosopher and Laxmana is a philosopher. But Rama and Laxmana are friends cannot be translated as R • L because here R • L stands for Rama is Friend and Laxmana is a friend and that is not equivalent to the ordinary sentence.

All the following propositions are Conjunctions. Because the main operator is a dot.

W • L, (W v L) • (D v L), ~ P • [W v (S ⊃ T)]

In disjunction, the wedge symbol (v) is used to translate "or", "unless" or any equivalent expression of "or". What we need to note here is that "or" can be used in inclusive or exclusive senses. When it taken in inclusive sense it means both the propositions connected by "or" can be true. For example- either he is a teacher or he is journalist. Here he actually can be both teacher and journalist. In exclusive sense the components cannot both true at the same time. For example- She went to London yesterday evening or she went to Washington. Here only one proposition can be true. All these types of propositions are translated using the wedge. When the main operator in a compound proposition is a wedge, it is a disjunctive proposition. Check these examples:

P v Q, Z v (G • L), (L• V) v (Q v ~ K)

In case of conditional or implicative propositions the horseshoe symbol is used to translate "if…then…", "only if" or any similar expressions. Please note that in case of Conditional statement the condition can be either sufficient (if indicated by "if") or a necessary (indicated by "only if") condition. Choosing the antecedent and consequent is thus may be little complex. The part that comes with "if" is always identified as antecedent. And what comes with "only if" is always considered as a consequent. For example- D only if M is translated as D ⊃ M, whereas D if M is translated as M ⊃ D.

Any logical expression that has horseshoe as the main operator is a conditional proposition. Take the following examples:

P⊃Q, Z⊃ (G • L), (L• V) ⊃ (Q v ~ K)

In case of Bi-Conditional Proposition the triple bar symbol is used to translate “if and only if” and similar expression. It indicates two conditions- necessary and sufficient. That is why this type of proposition is equivalent to two conditional propositions. For example, Mobile operator x decreases 4G service price if and only Mobile operator y decreases 4G service price. This can be symbolized as x≡y. The proposition can be expressed this way also: Mobile operator x decreases 4G service price if Mobile operator y decreases 4G service price (y⊃x) and Mobile operator x decreases 4G service price only if Mobile operator y decreases 4G service price (x⊃y).

This can be symbolized together as (y ⊃ x)•(x⊃y) and this is equivalent to x≡y.

The following compound propositions are all bi-conditional as the main operator is triple bar

~P ≡ Q, Z ≡(G • L), (L• ~V) ≡ (Q v ~ K)

14.3 WELL-FORMED FORMULAS

The symbolic expressions that we have shown in above examples are called **Well Formed Formulas (WFF)**. They are translations of meaningful and unambiguous sentences. Like a syntactically correct sentence these symbolic expressions are also syntactically correct. We can clarify this with an example- “Mary loves the colors of a rainbow”. This is a syntactically correct sentence. The meaning is clear and unambiguous. But “Rainbow the loves a Mary colors of” is not syntactically correct. Similarly, logical expressions can be syntactically correct or incorrect. The correct one is called WFF. Thus “P v Q~”, “v P•” these are not WFF.

There are some informal norms that we can follow to distinguish between WFFs and Non-WFFs.

Norms to Follow	Not WFFs	WFFs
Two or more Propositions cannot be combined without an operator occurring between them	AB A(AvB)	A v B A • (A v B)
A tilde cannot be placed immediately after a proposition, but it can be placed immediately before a	A~ (A v B) ~	~ A ~(A v B)

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proposition		
A tilde cannot be placed immediately before other operator.	~ • A A ~ v B	~ A• B A v ~ B
A dot, wedge, horseshoe, or triple bar must be placed between propositions	•A BC v ⊃ D F	A•B B v C F ⊃ D
Parentheses, brackets, and braces must be placed properly to prevent ambiguity	A • ~R v Q ≡ T v Z	A •[(~R v Q) ≡ (T v Z)]

Table 4

Check Your Progress I

Note: (a) Use the space provided for your answer.

(b) Check your answers with those provided at the end of the unit.

1. What is propositional Logic?

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2. Symbolize the following propositions using appropriate logical operators

(i) It is not the case that India will abandon the mission to Mars.

(ii) If the Amazon rainforest is destroyed, then global warming will further deteriorate.

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14.4 TRUTH FUNCTIONS

A Truth function can be understood in comparison to a mathematical function. Take this for instance: Y = X+2. Here the value of Y can be determined if we know the value of X. Suppose the value of X is 1. So the value of Y will be 3. Similarly, in Propositional Logic the value of a compound proposition is determined by the value of its components. The difference is that in Logic the values are not numbers but truth values. A proposition can be either true or false. The truth value a true proposition is "true" and the truth-value of a false proposition is "false".

A truth function is thus a compound expression whose truth value is completely determined by the value of its components. In logical expression our target is to find the value of the main operator on the basis of the value of all other operators and propositions etc. which are components of the compound proposition we are dealing with. However, in determining the value we need to follow the rules applicable for the five types of compound propositions we have discussed so far.

14.4.1 Statement form or propositional form

Here we need to note here that so far we were concerned with translation of propositions. To represent the propositions, we have used upper case letters of alphabet. But logic as you know is more concerned with logical forms than actual arguments or actual propositions. Therefore, here we are going to introduce what is called **statement form** or **propositional form**. Statement forms can be developed by using the operators and statement variables. Statement variables are lowercase letters. They can represent any proposition. The operators called logical constants, because they always are used in the same way. For example, "p v q" is a statement form. Here if we replace "p" and "q" with "A" and "B" we get a proposition "A v B". So a "statement form is an arrangement of statement variables and operators such that the uniform substitution of statements in place of the variables results in a statement'.

The nature of logical operators can be examined in terms of statement forms. This can be done by formulating Truth-Table for each statement forms. The truth table is an arrangement of truth values that shows in all possible case how the truth value of a particular compound proposition is determined by the truth values of its simple components. The truth value of simple proposition can be true or false. While formulating the table it is customary to use capital letter T for true and capital letter F for false.

Now let us consider tilde of a negation. The truth-table for negations shows how the truth-value of any propositions in negation form (~p) is determined by the truth values of the proposition that is negated (p).

14.4.1.1 Negation

p	**~p**
T	F
F	T

The truth-table shows that ~p is false when p is true and ~p is true when p is false. This we can apply wherever we find any expression with a negation.

Next we shall consider dot (•) of a conjunction. The truth-value of any proposition having the form of a conjunction (p•q) is determined by the value of its conjuncts (p,q):

14.4.1.2 Conjunction

p	**Q**	**p • q**
T	T	T
T	F	F
F	T	F
F	F	F

From this truth-table we can see that a conjunction is true only when its two conjuncts are true and it is false in all other cases.

Next we shall consider wedge (v) of a disjunction. The truth-value of any proposition having the form of a disjunction (pvq) is determined by the value of its disjuncts (p,q):

14.4.1.3 Disjunction

p	**q**	**p v q**
T	T	T

T	F	T
F	T	T
F	F	F

Here we can see that a disjunction is false only when both the disjuncts are false. In all other cases it is true.

Next we shall consider horseshoe (⊃) of a conditional (material implication). The truth-value of any proposition having the form of a conditional (p⊃q) is determined by the value of its antecedent (p) and consequent (q):

14.4.1.4 Conditional

p	**q**	**p ⊃ q**
T	T	T
T	F	F
F	T	T
F	F	T

The truth-table shows that a conditional is false when the antecedent is true and consequent is false. In all other cases it is true.

Finally, we shall consider triple bar (≡) of a Biconditional (material equivalence). The truth-value of any proposition having the form of a Biconditional (p ≡ q) is determined by the value of its components (p, q):

14.4.1.5 Biconditional

p	**q**	**p ≡ q**
T	T	T
T	F	F

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F	T	F
F	F	T

This truth-table shows that a Biconditional is true only when both the components have equal value whether it is false or true that is not an issue. But if the value of the components is different, then the conditional is false.

14.5 TRUTH-TABLE FOR PROPOSITIONS

In the above section we have learned the norms to determine the value of different operator. Now we shall see how truth-tables can be used to determine the value of complex propositions.

The truth table is an arrangement of truth values that shows in all possible case how the truth value of a particular compound proposition is determined by the truth values of its components. The method is presented in a table of values. There will be separate columns for each variables and operators. There will be one header row to write the letters and operators and below that there will be other rows showing the possible truth value for each component. In order to calculate the truth value of the compound proposition first we have to determine the number of possible cases for the component simple propositions. But how do we determine the number of all possible cases? There is a simple method. All compound propositions are constituted by simple propositions. Now we already know that a simple proposition has two possible truth values namely “true” and “false”. So if we have one simple proposition the possible case will be two. But if we have two simple propositions (for example p and q) then there will be the following possible case:

Possible Case 1: p could be true and q could be true

Possible Case 2: p could be true and q could be false

Possible Case 3: p could be false and q could be true

Possible Case 4: p could be false and q could be false

How did we calculate the possible number if we have more components? The formula is $L=2^n$. L is lines or rows of possible truth value combinations. Here n is the number of unique letter representing simple propositions. So if we have p, q, r as components of a compound proposition the number of possible cases will be $L=2^3$ and hence L=8. We shall have eight rows of values.

Now let us begin a truth-table for compound proposition. Let's take a very simple example first:

pv(q⊃ ~ p)

Here the number of simple propositions is two. Hence the number of possible cases will be four and the four lines will be placed immediately under the letters. In the next step we need to follow some norms so that all possible cases are actually written so that in every column and row we know where to put T and where to put F. The total number of rows shall be divided 2. Here 4 divided by 2 we get 2. So under two rows of the first letter we put T first then put F in the remaining rows. Next we divide the previous result of 2 by 2 again. This time we get 1. So under the second letter we put one T followed by one F and so on. Let's check-

<table>
<tr><td colspan="6">p v (q⊃ ~ p)</td></tr>
<tr><td>T</td><td></td><td>T</td><td></td><td></td><td></td></tr>
<tr><td>T</td><td></td><td>F</td><td></td><td></td><td></td></tr>
<tr><td>F</td><td></td><td>T</td><td></td><td></td><td></td></tr>
<tr><td>F</td><td></td><td>F</td><td></td><td></td><td></td></tr>
</table>

Here we see that every possible combination of truth and falsity are assigned under p and q. In case of the second p we can just copy the values from the first p.

<table>
<tr><td colspan="6">p v (q⊃ ~ p)</td></tr>
<tr><td>T</td><td></td><td>T</td><td></td><td></td><td>T</td></tr>
<tr><td>T</td><td></td><td>F</td><td></td><td></td><td>T</td></tr>
<tr><td>F</td><td></td><td>T</td><td></td><td></td><td>F</td></tr>
<tr><td>F</td><td></td><td>F</td><td></td><td></td><td>F</td></tr>
</table>

In the next step we need to find the values of the operators. We need to always find the value tilde first before other type of operators. Then we find the value of the operators which within bracket etc. Finally, we find value of the main operator that lies outside the scope of brackets or parenthesis. We need to follow these rules that we have earlier discussed regarding the operators.

<table>
<tr><td>p v (q⊃ ~ p)</td></tr>
</table>

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T	**T**	T	F	F	T
T	**T**	F	T	F	T
F	**T**	T	T	T	F
F	**F**	F	T	T	F

Here the value of the main operator wedge is computed from the column under p and horseshoe. Let us take another example with three different simple propositions.

p⊃(q v r)

p⊃ (qv r)				
T	**T**	T	T	T
T	**T**	T	T	F
T	**T**	F	T	T
T	**F**	F	F	F
F	**T**	T	T	T
F	**T**	T	T	F
F	**T**	F	T	T
F	**T**	F	F	F

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This compound proposition has three simple propositions and so we have 8 lines to write all possible combinations of truth and falsity. The main operator is a horseshoe. Therefore, following the rules for horseshoe this compound proposition is false in the row where the value of p is true but value wedge is false. We know that in a conditional proposition if the antecedent is true and consequent is false then the proposition is false.

In this way we can construct Truth-tables for any type of compound propositions.

14.6 TAUTOLOGY, SELF-CONTRADICTORY AND CONTINGENT PROPOSITIONS

On the basis of the truth-tables of the compound proposition we can classify propositions into three categories. As we have seen the value of the main operator can be all T or all F or some T, some F. When the main operator has only T under it that means the compound proposition is true even when the component propositions may be or may not be true. In this situation the proposition is called **Logically true** or **tautologous proposition**. On the other hand, if a compound proposition is false independently of the truth of its components, it is called **logically false or self-contradictory proposition**. And if a proposition's truth value is varying depending on the truth value of its components than its called **contingent proposition**. The easy way to identify these three: if all values under the main operator is T than it is a tautology; if all the values under the main operator are **F** than the proposition is Self-Contradictory. If the value under the main operator is at least once **T** and at least once **F** then the proposition is Contingent.

14.7 TRUTH-TABLE FOR ARGUMENTS

So far we have discussed about propositions and how to determine the truth value of propositions in propositional logic. But the main aim of logic is to deal with the validity of arguments. Propositional logic provides truth-table method as a standard technique to test the validity of an argument. To construct a truth table for an argument we need to follow certain steps.

First, symbolize the arguments using letters to represent the simple propositions.

Secondly write the symbolized argument like a symbolized proposition, put the first premise on the left-hand, the second premise next and the conclusion at the end. Place a single slash between the premises and a double slash between the last premise and the conclusion so that they are easily distinguishable.

Thirdly, draw a truth table for the symbolized argument in a similar ways just like a proposition showing the columns representing the premises and conclusion.

Finally, find a line of values in which all of the premises are true and the conclusion is false. If such a line exists, the argument is invalid; otherwise, it is valid.

For example, let us test the following argument for validity:

If Seema goes to Cinema than Mary stays at home

Seema does not go to Cinema

Therefore, Mary does not stay at home

Let us symbolize the argument

S ⊃ M

~S

. ˙ . ~ M

Now we can construct a truth table for this argument. Since the symbolized argument contains two letters so we shall have four lines of values. Next we shall assign the values under each letters. If there are identical letter the values will be same. In the next step we shall assign values under each column that represents the premises and the conclusion as per rules of those operators they contain. Thus we get the following truth-table.

S	⊃	M	/	~	S	//	~	M
T	**T**	T		**F**	T		**F**	T
T	**F**	F		**F**	T		**T**	F
F	**T**	T		**T**	F		**F**	T
F	**T**	F		**T**	F		**T**	F

Here you can see that in the third line both the premises are true but the conclusion is false. You have learned in previous units that in a valid argument if the premises are true then the conclusion must be true. If there is an F in any of the premises, then it does not matter if the value in that line in conclusion is F or T. But if in any line of values all premises column have T but conclusion column has F than by definition the argument is invalid. To understand clearly let us test a valid argument:

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G ⊃ ~H

~H ⊃ I

. ˙ . G ⊃ I

G	⊃	~	H	/	~	H	⊃	I	//	G	⊃	I
T	**F**	F	T		F	T	**T**	T		T	**T**	T
T	**F**	F	T		F	T	**T**	F		T	**F**	F
T	**T**	T	F		T	F	**T**	T		T	**T**	T
T	**T**	T	F		T	F	**F**	F		T	**F**	F
F	**T**	F	T		F	T	**T**	T		F	**T**	T
F	**T**	F	T		F	T	**T**	F		F	**T**	F
F	**T**	T	F		T	F	**T**	T		F	**T**	T
F	**T**	T	F		T	F	**F**	F		F	**T**	F

The main column of the premises and conclusion are shown in bold. In the eight lines of possible truth value combination there is no instance where all the premises are true and the conclusion is false. Therefore, this argument is a valid one. In this way we can easily test the validity of any argument.

14.8 INDIRECT TRUTH TABLE METHOD

Indirect Truth table method provides a shorter method of testing arguments using truth-table.

This method is very useful if we have arguments containing large number different simple propositions. In this method we need to work backward in comparison to normal truth-table.

We know that if an argument is valid and its premises are true then it’s impossible for the conclusion to be false. So in the indirect method we assign T under the premises’ column and F

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under the conclusion column. In the next step on the basis of these values and following the rules of the operators we assign values to the other components and finally the letters representing the simple propositions. If we can do this without any contradiction, then it means that it is possible that there will be at least one line of values where premises are true and conclusion is false. In that case the argument is not valid. But if arrive at contradiction, say at one place we have assign T under letter A and we have assigned F under A in another column then this is self-contradiction and it implies that the assumption that the premises are true and the conclusion false is self-contradictory. Hence indirectly the argument is proved to valid.

Let us test one argument using this method.

(A v B)⊃ (C •D)

(D v E) ⊃ F

∴ A ⊃ F

(A	V	B)	⊃	(C	•	D)	/	(D	V	E)	⊃	F	//	A	⊃	F
T	T		**T**	T	T	T		F	F	F	**T**	F		T	**F**	F

Here you can see that we have assigned T under both the premises and F under the conclusion. These three are values shown in bold letters. In the next step we assign truth value to A and F of conclusion. The conclusion is a Conditional proposition so here the proposition can be assigned F for one combination only, when antecedent is true and consequent false. So we put value T under proposition A and value F under proposition F. The values can be assigned to all occurrences of A and F. The first premise is a conditional proposition (A v B) ⊃ (C •D) and the value is T and its antecedent is a disjunctive proposition. We have already assigned T under A so the disjunctive proposition will be T in any case because disjunctive proposition is true when at least one of its disjuncts is true. Now since this is the antecedent of the main conditional proposition which needs to be true, therefore, the consequent (C •D) cannot be F. So we must put T under (C •D) which is a conjunctive proposition. A conjunctive proposition is true only when both the conjuncts are true. We must therefore assign T under both C and D.

Now let us check the second premise which is also a conditional proposition (D v E) ⊃ F. Here the value of proposition F (Consequent) is already assigned as an F. So we must assign F to the antecedent (D v E), also because otherwise the premise cannot be true. Now we have assigned F

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under (D v E), which is disjunctive proposition. A disjunctive is false only when both its disjuncts are false. So we are forced assign F under both D and E.

But we have already assigned T under D in the first premise. This means that if we are assuming this argument as invalid we shall face such self- contradiction in assigning truth values to the components. Hence indirectly the argument is proved to valid.

14.9 ARGUMENT FORMS

So far we have discussed about arguments expressed in logical symbols. We know that an argument is valid when it has a valid form. In Propositional logic many arguments are valid or invalid because of specific forms and these forms are given names. With the help of these we can immediately recognize if an argument is valid of invalid

We have previously discussed about Propositional forms. A propositional form is an arrangement of propositional variables and logical operators such that the uniform substitution of proposition in place of the variables results in a proposition. An example of a propositional form is p v q, where p and q are

If use proposition A and B in place variable p and q, we get the proposition A v B. Analogously, an argument form is an arrangement of propositional variables and operators such that the uniform substitution of propositions in place of the variables produces an argument. This resulting argument is termed as a substitution instance of its related argument form. For example, the following arrangement of statement variables and an operator is an argument form:

p •q

.˙. p

If the proposition A and B are uniformly substituted in place of the propositional variables p and q of this argument form, we get the following substitution instance, which is an argument:

A •B

.˙. A

Now in the same form we can have substitution instance with more complex propositions. But the form will be same and hence the validity will also be same.

(A v B) • (B⊃ D)

. ˙ . (A v B)

If the above argument form is valid then both these given examples are also valid because of the form. Whether the form is valid that can be tested in truth-table method.

Please note that any substitution instance of a valid argument form is always valid. Suppose there is an argument form from which we can have sometimes valid substitution instance. But if it has even one substitution instance in which the premises are true and the conclusion is false, then we must know that the argument form is invalid.

But how do we know that an argument form can have invalid substitution instances? Take the following example of an argument form:

P ⊃ q

q

. ˙ . p

When we construct a truth-table for this argument form there will be four lines of truth value combination. These lines represent all possible cases and hence all possible categories of substitution instances.

p	⊃	q	/	q	//	P
T	T	T		T		T
T	F	F		F		T
F	T	T		T		F
F	T	F		F		F

Now checking this truth-table we find that in the third line the first premise p⊃q has T, the second premise q has T but the conclusion p has F as truth value. This means there is at least one substitution instance of the given argument form in which the premises can be true yet the conclusion is false. By the definition of validity, the argument form is therefore invalid. Now let us consider some valid argument forms.

14.9.1 Valid Argument Forms

14.9.1.1 Disjunctive Syllogism (DS)

p v q

~ p

$\therefore$ q

Let us check this form using a truth-table.

p	v	q	/	~	p	//	q
T	T	T		F	T		T
T	T	F		F	T		F
F	T	T		T	F		T
F	F	F		T	F		F

From this table we can see that there is not a single line where both the premises are true and the conclusion is false. In the third line both premises have T and the conclusion also has T. So this argument form is a valid one. Any argument which is substitution instance of this argument form will be valid. This form is termed as Disjunctive Syllogism. Please note that substitution instance must be exact replacement of each variable. If we replace q with a substitution instance that is supposed to be replacement of p, for then it is not correct substitution instance.

14.9.1.2 Hypothetical Syllogism (HS)

$p \supset q$

$q \supset r$

$\therefore p \supset r$

To show the validity of this form the following truth-table is constructed.

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P	⊃	q	/	q	⊃	r	//	p	⊃	r
T	T	T		T	T	T		T	T	T
T	T	T		T	F	F		T	F	F
T	F	F		F	T	T		T	T	T
T	F	F		F	T	F		T	F	F
F	T	T		T	T	T		F	T	T
F	T	T		T	F	F		F	T	F
F	T	F		F	T	T		F	T	T
F	T	F		F	T	F		F	T	F

In all the lines above there is not a single instance where both the premises are true and the conclusion false. This argument form is a valid one. In this argument form the propositions are linked like a chain. So in a substitution instance component should be uniformly substituted.

14.9.1.3 Modus Ponens (MP)

p ⊃ q

p

∴q

Any argument of this form is valid. Let us test it:

p	⊃	q	/	P	//	q
T	T	T		T		T
T	F	F		T		F
F	T	T		F		T
F	T	F		F		F

Here you can see that there is no possible arrangement where both the premises are true and the conclusion is false. Wherever there is F in the conclusion column we can find F in at least of one the premise column also.

14.9.1.4 Modus Tollens (MT)

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p ⊃ q

~q

. ˙ .~p

p	⊃	Q	/	~	q	//	~	p
T	T	T		F	T		F	T
T	F	F		T	F		F	T
F	T	T		F	T		T	F
F	T	F		T	F		T	F

There is only one line where both the premises have T and the corresponding conclusion line also have T. So any substation instance of this form will be valid argument. Therefore, the argument form is a valid one.

In this way we can find 9 different forms of argument which are regarded as elementary valid argument forms. Any substitution instance of these forms shall result in valid arguments. These 9 forms are very useful in testing the validity of arguments.

Check Your Progress II

Note: (a) Use the space provided for your answer.

(b) Check your answers with those provided at the end of the unit.

1. In what condition a disjunctive function becomes false?

----

2. Test the following argument using Truth table.

p v (p • q)

P

. ˙ . q

14.10 FORMAL PROOF OF VALIDITY

Truth-table method becomes very difficult when the number of component propositions increases. Suppose there are five different simple propositions in an argument. Then the number of rows in truth-table will be 32. It will be cumbersome to assign and check all the values in a table form. Logicians therefore use a more convenient shorter method. In this method the validity of argument is established by deducing the conclusions from the premises by a sequence of elementary argument forms whose validity is already proved.

An elementary valid argument form is defined as any argument that is a substitution instance of an elementary valid argument form. For example, there is a valid form called *Modus Ponens*. If there is a substitution instance of this form in the argument, then argument is valid. There are nine elementary valid argument forms accepted as Rules of Inference. However, there are many valid truth-functional arguments that cannot be proved valid using simply the nine Rules of Inference. We need additional rules in such cases. The Rule of Replacement is an additional principle of inference. There are ten rules of Replacement which allows us to replace any component of a proposition which is logically equivalent to that part as per these rules. Using these19 rules we can easily prove the validity of complex arguments just in few steps.

14.11 A NOTE ON INDIAN LOGIC

Propositional Logic is a largely a contribution of modern western logician. But as we have already seen the seed of this approach was already contained in Aristotelian logic where standard form syllogism was developed and the terms of the propositions were symbolically represented for easy and fast identification of the syllogistic forms. Can we find similar traces Indian Logic also?

The oldest Indian text which hints at the knowledge of some theorems of propositional calculus is the *Kathāvatthu*. This text discusses heretical theses following a stereotypical schema, which had been expressed as follows: 'if A is B, then C is D; but C is not D; therefore, A is not E'. As one can see, this formula is equivalent to the *Stoic modus Tollens*. According to Ganeri, the elements with which the logic in the *Kathāvatthu* operates are evidently propositional variables. In his commentaries, Buddhaghosha calls the conclusion from the premise $p \supset q$ 'direct' (*anuloma*) and the conclusion from the premise $\sim q \supset \sim p$ 'inverse' (*pratiloma*). So we can say that Indian Logic also carried some traces of propositional logic.

14.12 LET US SUM UP

In this Unit we have learnt about various aspects of propositional logic. We have seen that unlike Traditional Logic, Propositional Logic, while dealing with arguments, considers the whole proposition and not concerned with the terms of the proposition. Since it deals with Propositions or logical sentences, it is known as Propositional Logic and sometimes it is also called Sentential Logic. Propositional Logic thus does not analyze the internal structure of the proposition. Propositional Logic can represent complex arguments in a symbolic form and determining the validity of such arguments become very easy.

14.13 KEY WORDS

Argument Form: An argument form is an arrangement of propositional variables and operators such that the uniform substitution of propositions in place of the variables produces an argument.

Compound Proposition: A Compound Proposition can be defined as a proposition containing one or more simple propositions as component.

Propositional Logic: Propositional Logic, while dealing with arguments, considers the whole proposition and not concerned with the terms of the proposition. Since it deals with Propositions or logical sentences, it is known as Propositional Logic and sometimes it is also called Sentential Logic.

Simple Proposition: Simple Proposition is a proposition that does not contain any other proposition as it’s component.

14.14 FURTHER READINGS AND REFERENCES

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14.15 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress I

1. Propositional Logic deals with Propositions or logical sentences. It is known as Propositional Logic and sometimes it is also called Sentential Logic. Propositional Logic thus does not analyze the internal structure of the proposition h arguments, considers the whole proposition and not concerned with the terms of the proposition.

2. (i) It is not the case that India will abandon the mission to Mars.

It is not the case that M

~M

(ii) If the Amazon rainforest is destroyed, the global warming will further deteriorate

If A then G

A ⊃ G

Check Your Progress II

1. In disjunctive function becomes false when both the disjuncts are false.

p	V	(p	•	q)	/	p	//	q
T	T	T	T	T		T		T
T	T	T	F	F		T		F
F	F	F	F	T		F		T

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2.

F	F	F	F	F		F		F

In the 2nd line both premises are true but the conclusion is false. Therefore, the argument form is invalid.

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